A REVIEW OF THE WATER SNAKES OF THE GENUS *NATRIX* IN MEXICO

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ROGER CONANT

Research Associate, Department of Herpetology
The American Museum of Natural History
Director and Curator of Reptiles
Philadelphia Zoological Garden

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INTRODUCTION

ALMOST THREE DECADES AGO, when plans were developing for broad studies on North American water snakes, it quickly became apparent that only meager information was available on the distribution and speciation of the genus *Natrix* in Mexico. At that time there probably were fewer than 100 specimens from mainland Mexico in all museum collections combined, and series were available from only a few scattered localities. Paradoxically, the only large sample suitable for studies on variation in pattern and scutellation was from the Cape Region of Baja California, a remote area that is still difficult of access. The abundance of *Natrix valida celaeno* in certain streams discharging from the canyons of the Cape mountain massif, plus the novelty of finding a semiaquatic reptile on a peninsula noted, throughout most of its length, for its extreme aridity, were doubtless sufficient stimuli for naturalists visiting the region to preserve any and all specimens they could. In contrast, when I first surveyed the *valida* complex (Conant, 1946), only 31 specimens were available from mainland localities.

The paucity of material has long since been remedied. For example, the sample of mainland *valida* is now 17 times what it was in 1946. The increase in the number of specimens has resulted partly from our personal field work, but more importantly because the opening of new roads in Mexico has enabled many collectors to work in areas with ease that formerly could be penetrated only through the use of pack trains or long excursions on foot.

The increment of so much additional material, as so often happens, raised more problems than it solved, but fortunately there has been time to investigate a number of the newly opened avenues of interest. As a result, the present report is much longer but is also far more comprehensive than was originally contemplated.

In Mexico many of the *Natrix* populations are isolated from other populations of the same species by barriers of elevation or aridity that they are unable to cross, and examining the effects of isolation on the water snakes in various river systems was one of the most intriguing facets of the present study. In such regions as the great plexus of rivers and swamps of Tabasco and the adjacent states, *Natrix* is widespread, but in other areas, notably in streams of interior drainage, such as the Río Nazas and the Río Aguanaval of the northern *altiplano*, isolation is complete. Isolation also occurs in numerous other streams of northern Mexico. Although they have maritime outlets, many, such as the Río Yaqui, Río Mayo, and Río Fuerte on the west coast and the Río San Fernando and Río Purificación on the east coast, all have *Natrix* populations, but they have long been separated from one another by arid regions inhospitable to semiaquatic snakes.

Mrs. Conant and I spent a total time of almost a year in Mexico, most of which was devoted to field work in pursuit of snakes of the natricine genera *Natrix* and *Thamnophis*. A detailed itinerary of our travels appears on pages 18 to 20. Many of the more productive localities were visited several times, as were some of the unproductive ones, such as a number in the Río Nazas system from which study material was especially desired.

The ranges of the several species probably are delineated with some degree of completeness in northern Mexico, but those in the south should be treated with far less confidence. *Natrix valida* certainly must occur in some, at least, of the coastal streams and lagoons well southeast of Acapulco, but such probable occurrence has not yet been demonstrated, largely because the region has been inaccessible until very recently. We hunted unsuccessfully for *valida* in several of the small streams in Oaxaca near Tapanatepec and Zanatepec, in the Río Tehuantepec at Tehuantepec and the Presa Juárez, and in the Río Tequisistlán at Tequisistlán. We also made an abortive attempt to reach the fresh-water lagoon near Puerto Angel.

Natrix rhombifera assuredly must occur in many localities in Campeche, Chiapas, and Oaxaca that are adjacent to Tabasco, and, although we tried to "push it over the line" in each of those states by working along the

rivers and swamps that are approachable by road, we failed to do so in the limited time we budgeted for field work in southern Mexico. There is now a record, however, from the Río San Pedro y San Pablo where it forms part of the boundary between Tabasco and Campeche, and another from barely within the border of Chiapas. No doubt numerous other localities will be added as field work progresses along the new highway that extends eastward from Villahermosa. It is possible that *rhombifera* may also occur in Guatemala, perhaps in the drainage systems of the Ríos Usumacinta and San Pedro that cross Mexico downstream and flow, in part, into the enormous swamps southwest of the Laguna de Terminos. Certainly there are abundant water-snake habitats in the vast wetlands of the region, which is the rainiest in Mexico (2500 mm. to 3500 mm. of precipitation annually, according to Sanchez, 1936, map 11), but, until roads are built into or across them, significant additional localities for *Natrix* will be added only as collecting parties proceed by boat or air into this wilderness. Smith obtained a single specimen from Emiliano Zapata, Tabasco, during a river-boat trip on the Río Usumacinta (Smith and Taylor, 1950b, p. 6). It was tempting to speculate on the prospects of a similar excursion, but it appeared unwise for us to involve so much time and expense almost solely for the purpose of adding a few spots to the distribution map, so it is left to future collectors to work out the southernmost limits of the genus *Natrix* in the New World.

Several alleged but obviously erroneous "records" for *Natrix* in Mexico and Central America require comment. One of these, for Tenedores, Guatemala, was questioned by Hamilton (1947), who suggested that snakes from Indiana were incorrectly ascribed to that country, a supposition with which I agree. I have examined the specimens in question (U.S.N.M. Nos. 48963, 48964), and they closely match members of the *Natrix sipedon* complex from Indiana. They are credited to Newton Miller, are dated 1905, were allegedly taken by him while making fish collections, and were shipped from Indiana University, at Bloomington, Indiana, to the United States National Museum (*fide* Hamilton, *loc. cit.*), where they were catalogued on June 14, 1912. Evidently some error was involved that resulted in assigning incorrect data to two Indiana snakes.

McLain (1899, p. 3) mentioned a small specimen of "*N. f. sipedon*" from "Mexico" in the collection of Stanford University (S.U. No. 4031), and the British Museum (Natural History) has four specimens of *sipedon* (B.M.N.H. Nos. 71.11.22.1–71.11.22.4) allegedly from Cartago, Costa Rica. I have seen all five of these snakes, and they are identifiable as *Natrix sipedon*. These also must bear incorrect data. *Natrix sipedon* is otherwise unrecorded from either Mexico or Central America, and in the United States it does not occur farther southwest than the Red River region of southeastern Oklahoma and (probably) adjacent Texas (Conant, 1963a, fig. 1B).

Boulenger (1893, p. 241) reported *Tropidonotus* (=*Natrix*) *grahami* from "Mexico." I have examined this specimen (B.M.N.H. No. 58.9.1.5), and it is undoubtedly *grahami*, but there is no confirmation that the species occurs in Mexico. The known range of *grahami* does not extend farther south than Bexar County, Texas (Brown, 1950, p. 189). Faulty data are again suspected, for Alice G. C. Grandison, of the British Museum (personal communication), advises me that this snake was acquired from a London dealer, Charles Jamrach, about a century ago, and that most of Jamrach's material lacked locality data entirely or was labeled simply "Mexico," "South Africa," "Philippines," and so on.

To complete the list of alleged records from Central America, mention should be made that Smith and Taylor (1945, p. 154) included "Guatemala" in their statement on the range of the genus *Natrix*, but on the next page, under the section for *rhombifera*, they qualified it as "possibly also Guatemala." As indicated above, I have been unable to find any valid records from east or south of Tabasco and Chiapas, and Stuart (1963) did not include the genus in his checklist of the herpetofauna of Guatemala.

It has not been possible, of course, to visit every stream or other body of fresh water in Mexico where *Natrix* may occur, and there are literally scores of them, even in arid

regions, where it might be profitable to search. Although *Natrix* is usually easier to find in the field than snakes of most other North American genera, there is much merit in the statement by Smith and Taylor (1948, p. 2), that success in collecting often is a matter of being in the right place at the right time. On many occasions we failed to obtain natricine snakes in localities where on later nights and under virtually identical weather conditions they were abundant.

A parallel study on the semiaquatic garter snakes of the *Thamnophis eques* and *Thamnophis melanogaster* complexes is currently in progress, and our field work in Mexico in 1964, 1965, and 1967 was devoted largely to them. A considerable number of specimens of *Natrix*, some from important localities, was also obtained, however, and data derived from them are incorporated in the present paper. The work on the garter snakes will not be completed for some years, but it seems expedient to include herein our entire itinerary and to make acknowledgment to the many people who have helped, rather than to wait to bring the record up to date at a later time.

All localities for the *Natrix erthyrogaster* and *N. rhombifera* complexes from the drainage system of the Rio Grande in the United States are listed and mapped in the present paper, and comment is made about several of them. The snakes, of course, are unaware of international boundaries, and the post-Pleistocene desiccation that has fragmented the ranges of these species in northern Mexico has produced similar results in Texas and New Mexico. It seemed expedient to present the entire distributional picture, as it is currently known, but detailed studies on scutellation, patterns, and local variations of the populations occurring within the borders of the United States are reserved for later publications.

ACKNOWLEDGMENTS

More than 150 persons have assisted in one way or another with the field, laboratory, or reference work associated with the preparation of the present paper.

Dr. Charles M. Bogert has maintained a lively interest in the project since its inception, worked with us in southern Mexico during 1959 and 1962, and made the facilities of the Department of Herpetology of the American Museum of Natural History available to me for research purposes for more than two decades.

Dr. James D. Anderson, Mr. Robert Giacosie, Dr. John M. Legler, Dr. T. Paul Maslin, Dr. Clarence J. McCoy, Jr., and Mr. Charles E. Shaw, in addition to aiding in other ways, all met or accompanied us in the field and shared with us the inconveniences, enthusiasm, and stimulation that are an inherent part of all collecting expeditions.

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herpetofauna of the Neotropical Region in general, contributed especially useful information, read portions of the manuscript, or assisted with various problems. They are Dr. Ralph W. Axtell, Mr. William S. Brown, the late Dr. Doris M. Cochran, Dr. William E. Duellman, Dr. Richard E. Etheridge, the late Dr. Norman E. Hartweg, the late Dr. Laurence M. Klauber, Dr. Roy W. McDiarmid, Dr. Wendell L. Minckley, Dr. Sherman A. Minton, Jr., Dr. James A. Peters, Mr. Neil D. Richmond, Dr. William J. Riemer, Dr. Hobart M. Smith, Dr. Philip W. Smith, Dr. Robert G. Webb, and Dr. Richard G. Zweifel.

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For such various favors as lending me specimens in their custody, offering information, patiently answering queries about confusing locality data, altering their itineraries in Mexico at my request to collect at critical localities, or for giving me live or preserved specimens, I am indebted to a large number of persons whose names are as follows: Dr. Kraig K. Adler, Mr. Rudolph Arndt, Mr. E. N. Arnold, Dr. Walter Auffenberg, Mr. Charles Babcock, Dr. Rollin H. Baker, Dr. Richard J. Baldauf, Dr. Clyde D. Barbour, Mr. J. C. Battersby, Mr. Ted Beimler, Dr. Albert P. Blair, Dr. W. Frank Blair, Dr. James E. Böhlke, Mr. Peter Bottos, Dr. W. J. Breckenridge, Dr. Bryce C. Brown, Mr. Edward Bush, Mr. Duke Campbell, Dr. Howard Campbell, Dr. Archie Carr, Dr. Pete S. Chrapliwy, Mr. Robert G. Crippen, Mr. Lawrence Curtis, Mr. and Mrs. Mark Daniel, Dr. William G. Degenhardt, Dr. Robert W. Dickerman, Dr. James R. Dixon, Dr. Charles L. Douglas, Dr. Herndon G. Dowling, Dr. Harold A. Dundee, the late Dr. Emmett Reid Dunn, Dr. M. J. Fouquette, Jr., Dr. Warren C. Freihofer, Dr. Fred R. Gehlbach, Dr. Howard K. Gloyd, Miss Alice G. C. Grandison, Dr. Allen E. Greer, Dr. Arnold B. Grobman, Dr. Laurence M. Hardy, Mrs. Bessie Matalas Hecht, Dr. Max M. Hensley, Dr. Carl L. Hubbs, Dr. Victor H. Hutchison, Dr. Robert F. Inger, Dr. Pauline James, Mr. Harvey S. Janson, Mr. Jerry A. Johnson, Mr. Tim Jones, Mr. and Mrs. Joseph Jordan, Mr. Carl F. Kauffeld, Dr. Edmund D. Keiser, Jr., Dr. W. A. King, Jr., Dr. Konrad Klemmer, Mrs. Ida Langman, Mr. Joseph R. Lannom, Jr., Mr. Joe LaPointe, Dr. James N. Layne, Dr. Alan E. Leviton, Mr. Ernest A. Liner, Mr. Thomas G. Logan, Dr. Richard B. Loomis, Dr. Charles H. Lowe, Jr., Mr. John D. Lynch, Dr. Paul S. Martin, Mr. Hymen Marx, Dr. John A. Moore, Mr. and Mrs. Carlos Moreno, Mr. Elkan J. Morris, Mr. John R. Myer, Dr. George S. Myers, Dr. M. Graham Netting, Dr. Max A. Nickerson, Mr. Lewis D. Ober, Dr. James A. Oliver, Mr. Richard B. Parker, Dr. Dennis R. Paulson, Mr. Clifford H. Pope, Dr. Edward C. Raney, Dr. Gerald A. Raun, Mr. Bernard Roseman. Mr. Ottys Sanders, Dr. Jay M. Savage, the late Dr. Karl P. Schmidt, Dr. Fred W. Schuierer, Mr. Norman Scott, Mr. James F. Scudday, Mrs. Frances Humphrey Shannon, the late Dr. Frederick A. Shannon, Mr. Samuel Sikes, Mr. Morris Silverman, Mr. Allan J. Sloan, Mrs. Dorothy Smith, Dr. Robert C. Stebbins, Mr. Paul L. Swanson, Dr. Wilmer W. Tanner, Dr. Edward H. Taylor, Dr. Fred G. Thompson, Dr. Donald W. Tinkle, Dr. Thomas M. Uzzell, Dr. Charles F. Walker, Dr. Dwain W. Warner, Mr. Roland H. Wauer, Mr. John E. Werler, Dr. Ernest E. Williams, Dr. Larry David Wilson, Mr. John C. Wottring, Dr. John W. Wright, and Mr. R. Peter Yingling.

Mr. Edmond V. Malnate painted the watercolors from life that are reproduced as plates 1 and 2, executed the draftsmanship on maps 3, 5, and 6 from my detailed layouts, and assisted in many other ways. Dr. Rodolfo Ruibal prepared the summary in Spanish that appears on page 133. Mrs. Norma Rothman recorded the majority of the scale counts and measurements. The manuscript was typed by Mrs. Ruth G. Endy. Mrs. Lillian C. Jones, of the library staff at the Academy of Natural Sciences of Philadelphia, was especially patient in finding maps and references for me. Mr. Edward T. Endy, Mrs. Sarah Cunius, and Mr. Ray Hance, all members of the reptile house staff

at the Philadelphia Zoological Garden, assisted in caring for living study specimens and recording observations on them.

The drainage map of Mexico (Miller, 1968), used in the preparation of maps 1, 2, and 4, is from the Museum of Zoology of the University of Michigan. The other maps in the present paper were drafted from several sources, including the 1:1,000,000 sheets of the "Map of Hispanic America," published by the American Geographical Society of New York; the 1:500,000 sheets of "La carta general de la República Mexicana," published by the Ex-Comisión Intersecretarial de México, D. F.; and the 1:1,000,000 "Operational Navigation Charts" of the United States Air Force.

Special acknowledgment must be made to the Board of Directors of the Zoological Society of Philadelphia and the late Mr. Radcliffe Cheston, Jr., former President of the Board, for granting me a leave of absence from my duties at the Philadelphia Zoological Garden during each of six summers so that I could undertake field work in Mexico.

Our expeditions during 1959 to 1962, inclusive, and during 1964 and 1965 were supported by the National Science Foundation (Grants G-9040, G-22657, and GB-2177); field work during 1949 and 1967 was supported in part by the Zoological Society of Philadelphia.

My wife, Mrs. Isabelle Hunt Conant, has contributed far more to this research than any other person. She prepared figure 3 for the present paper and made thousands of photographs in the field and studio, many of which are reproduced on plates 3 to 22, inclusive. She was my constant and staunch companion during almost a full year of travel in Mexico, and she has assumed many routine duties that normally would be mine so that my time could be devoted to laboratory and writing chores. Without her never-flagging assistance this work could not have been completed and probably would never have been attempted.

MATERIAL EXAMINED

A total of 1373 specimens of Mexican members of the genus *Natrix* was examined during the course of the present study, and scale counts, pattern notes, and measurements were recorded for most of them. In addition, for comparative purposes, similar data were assembled for 90 snakes of the *N. erythrogaster* and *N. rhombifera* complexes from the Rio Grande and Pecos River drainages in southern and western Texas and southeastern New Mexico. An attempt was made to examine all Mexican material catalogued in museum collections up to the end of 1966. Collecting localities and certain pertinent data are also included, however, for a few snakes obtained through the efforts of field parties that were active in Mexico during 1967.

With the exception of the type of *Tropidonotus quadriserialis* Fischer (1879), I have been able to study the types and virtually all members of the type series (variously labeled cotypes, paratypes, and syntypes) of all 10 taxa from Mexico that I recognize as valid.

Specimens mentioned in the text are designated by the following abbreviations, indicating the collections to which they belong:

A.M.N.H., the American Museum of Natural History
A.N.S.P., Academy of Natural Sciences of Philadelphia
A.S.U., Arizona State University, Tempe
B.C.B., Bryce C. Brown collection, Waco, Texas
B.M.N.H., British Museum (Natural History), London
B.U., Baylor University, Waco, Texas
C.A., Chicago Academy of Sciences
C.A.S., California Academy of Sciences, San Francisco
C.C.N.P., Carlsbad Caverns National Park, Carlsbad, New Mexico
C.M., Carnegie Museum, Pittsburgh
C.U., Cornell University, Ithaca, New York
D.B.U.N.M., Department of Biology, University of New Mexico, Albuquerque
E.A.L., Ernest A. Liner collection, Houma, Louisiana
E.D.A., Ernest Donald Ashurst collection, Lafayette, Louisiana
E.H.T.-H.M.S., Edward H. Taylor-Hobart M. Smith collection. (This large collection no longer exists as a separate entity; approximately two-thirds of it is now at the Field Museum of Natural History, and the remaining one-third is at the University of Illinois Museum of Natural History. In this paper all pertinent specimens are designated by the initials of those two institutions; the E.H.T.-

H.M.S. numbers are given only for specimens that are cited from the literature and that I have not examined personally.)

F.A.S., Frederick A. Shannon (the collection of the late Dr. Shannon has been deposited in the University of Illinois Museum of Natural History, Urbana)

F.M.N.H., Field Museum of Natural History (known as the Chicago Natural History Museum from 1943 to 1966, inclusive)

I.B.U.N., Instituto Biología, Universidad Nacional de México, México, D. F.

I.N.H.S., Illinois Natural History Survey, Urbana

K.U., the University of Kansas Museum of Natural History, Lawrence

L.A.C.M., Los Angeles County Museum

L.B.S.C., Long Beach State College, Long Beach, California

L.D.W., Larry D. Wilson collection, Baton Rouge, Louisiana

L.S.U.M.Z., Louisiana State University Museum of Zoology, Baton Rouge

M.C.Z., Museum of Comparative Zoology, Harvard University, Cambridge

M.M.N.H., Minnesota Museum of Natural History (as this paper was being readied for publication the name of this institution was changed to the James Ford Bell Museum of Natural History, Minneapolis)

M.S.U., the Museum, Michigan State University, East Lansing

M.V.Z., Museum of Vertebrate Zoology, University of California at Berkeley

N.H.S.S.D., Natural History Society of San Diego

P.S.C., C.B.H., Pete S. Chrapliwy, Carlsbad Highway collection, El Paso, Texas

R.A.T., Robert A. Thomas collection, Lafayette, Louisiana

R.W.A., Ralph W. Axtell collection, Alton, Illinois

S.M.F., Senckenberg Museum, Frankfurt, West Germany

S.R.S.C., Sul Ross State College, Alpine, Texas

S.U., Stanford University, Stanford, California

T.C.W.C., Texas Cooperative Wildlife Collection, Texas Agricultural and Mechanical University, College Station, Texas

T.N.H.C., Texas Natural History Collection, Department of Zoology, University of Texas, Austin

T.U., Tulane University, New Orleans

U.A.Z., University of Arizona, Department of Zoology, Tucson

U.C.M., University of Colorado Museum, Boulder

U.F., University of Florida, Gainesville

U.I.M.N.H., University of Illinois Museum of Natural History, Urbana

U.S.L., University of Southwestern Louisiana, Lafayette

U.M.M.Z., University of Michigan Museum of Zoology, Ann Arbor

U.S.N.M., United States National Museum, Smithsonian Institution, Washington, D. C.

U.U., University of Utah, Salt Lake City

W.G.D., William G. Degenhardt collection, Albuquerque, New Mexico

METHODS USED IN RECORDING DATA

Scale counts were made in accordance with generally accepted practices. The system proposed by Dowling (1951b) was followed for ventrals; the anal plate, which is divided in all except a relatively few Mexican specimens of *Natrix*, was not included in the counts. The numbers of subcaudals refer to pairs of scales, and they do not include the terminal scale (often spinelike) at the tip of the tail. The formulas for expressing scale-row additions and reductions follow the method used by Duellman (1958, p. 9), in his modification of the Dowling (1951a) system. Among the snakes of all three species, and in both sexes, the number of dorsal rows may decrease or (rarely) increase by one scale immediately anterior to the anal region through the loss or gain of an extra row. Such minor changes are not included among the data in tables 5 and 6.

Measurements were made with a meter stick or steel tape. Lengths of snakes, unless otherwise stated, are total lengths. Plus signs accompanying such measurements indicate that a terminal portion of the tail is missing. Tail lengths were measured from the anal plate to the tip of the tail. Because it is virtually impossible to measure a preserved snake (or a live one, for that matter) with precision, the tail length/total length ratios were carried to only two decimal places instead of to three as some herpetologists persist in doing. The horizontal diameter of the eye and the distance from the eye to the nostril were measured with vernier calipers, but vagaries in methods of preservation and varying interpretations of where the nostril terminated posteriorly, depending in part on whether the nasal valve was open or closed, precluded the accumulation of highly accurate data. Measurements were made on all wild-caught, undamaged snakes and on at least six members of each captive-born litter. The resultant data, although scarcely

TABLE 1

VARIATION IN THE NUMBER OF VENTRALS

Taxon	Males			Females		
	N	Range	Mean	*N*	Range	Mean
e. alta	58	138–143	140.0	54	140–144	142.1
e. bogerti	13	141–145	143.1	19	143–148	145.2
e. transversa	66	138–145	141.2	65	137–146	142.0
r. blanchardi	60	139–150	143.2	46	136–150	141.1
r. rhombifera	37	141–152	146.0	29	137–146	141.8
r. werleri	39	137–145	141.4	34	135–142	138.5
v. celaeno	60	135–146	142.1	65	134–145	141.1
v. isabelleae	20	131–137	134.0	37	130–138	133.7
v. thamnophisoides	56	130–140	135.3	63	127–139	133.6
v. valida	134	136–150	141.7	126	132–147	140.3
v. intergrades[a]	32	134–145	139.2	49	132–144	136.5

[a] Intergrades among three taxa: *valida* × *isabelleae* × *thamnophisoides.*

TABLE 2

VARIATION IN THE NUMBER OF SUBCAUDALS

Taxon	Males			Females		
	N	Range	Mean	*N*	Range	Mean
e. alta	58	84–90	87.1	48	69–76	73.0
e. bogerti	13	82–85	83.4	19	68–76	71.6
e. transversa	62	76–87	81.8	63	64–77	70.0
r. blanchardi	45	76–88	81.3	39	63–73	68.6
r. rhombifera	31	68–77	72.2	24	56–66	60.0
r. werleri	33	78–86	82.2	30	64–73	68.0
v. celaeno	50	74–82	78.1	54	67–75	71.0
v. isabelleae	12	76–81	78.3	30	68–76	72.4
v. thamnophisoides	39	69–80	74.3	35	65–73	68.7
v. valida	109	70–86	77.8	100	61–78	70.4
v. intergrades[a]	25	70–82	76.4	29	64–74	69.4

[a] Intergrades among three taxa: *valida* × *isabelleae* × *thamnophisoides.*

TABLE 3

VARIATION IN THE MAXIMUM NUMBER OF DORSAL SCALE ROWS AMONG MEXICAN RACES OF *Natrix erythrogaster* AND *Natrix rhombifera*

Taxon	Males						Females					
	23	24	25	26	27	Total	23	24	25	26	27	Total
e. alta	—	4	54	—	—	58	—	—	41	13	—	54
e. bogerti	2	8	3	—	—	13	1	5	12	1	—	19
e. transversa	13	6	49	—	—	68	1	4	52	7	4	68
r. blanchardi	2	—	55	2	2	61	—	—	21	8	17	46
r. rhombifera	—	3	17	4	14	38	—	—	4	—	26	30
r. werleri	—	—	25	3	11	39	—	—	13	1	22	36

TABLE 4

VARIATION IN THE MAXIMUM NUMBER OF DORSAL SCALE ROWS AMONG THE RACES OF *Natrix valida*

Taxon	Males				Females					
	19	20	21	Total	19	20	21	22	23	Total
celaeno	54	1	9	64	26	4	33	3	1	67
isabelleae	19	—	1	20	32	2	3	—	—	37
thamnophisoides	56	—	1	57	56	—	7	—	—	63
valida	134	1	1	136	116	5	6	—	—	127
Intergrades[a]	31	—	2	33	46	—	3	—	—	49

[a] Intergrades among three taxa: *valida* × *isabelleae* × *thamnophisoides*.

TABLE 5

VARIATION IN THE MINIMUM NUMBER OF DORSAL SCALE ROWS AMONG MEXICAN RACES OF *Natrix erythrogaster* AND *Natrix rhombifera*[a]

Taxon	Males									Females								
	16	17	18	19	20	21	22	23	Total	16	17	18	19	20	21	22	23	Total
e. alta	—	19	23	16	—	—	—	—	58	—	9	19	26	—	—	—	—	54
e. bogerti	—	4	2	7	—	—	—	—	13	—	5	2	12	—	—	—	—	19
e. transversa	13	44	5	6	—	—	—	—	68	12	18	25	13	—	—	—	—	68
r. blanchardi	—	3	1	50	3	4	—	—	61	—	—	—	16	6	24	—	—	46
r. rhombifera	—	1	4	6	6	21	—	—	38	—	—	—	1	5	23	—	1	30
r. werleri	—	—	—	12	4	22	—	1	39	—	—	—	2	3	30	—	1	36

[a] Irregularities that result from the loss or (rarely) a gain of one scale row immediately anterior to the anal region are not included.

TABLE 6

VARIATION IN THE MINIMUM NUMBER OF DORSAL SCALE ROWS AMONG THE RACES OF *Natrix valida*[a]

Taxon	Males				Females			
	15	16	17	Total	15	16	17	Total
celaeno	1	—	63	64	—	—	67	67
isabelleae	—	—	20	20	—	1	36	37
thamnophisoides	1	2	54	57	—	—	61	61
valida	3	9	124	136	2	6	119	127
Intergrades[b]	—	1	32	33	—	3	46	49

[a] Irregularities that result from the loss or (rarely) a gain of one scale row immediately anterior to the anal region are not included.

[b] Intergrades among three taxa: *valida* × *isabelleae* × *thamnophisoides*.

precise, do permit interpretations of general proportions, as stated in the pertinent parts of the text. Methods of measuring the length of the frontal and parietal scales in snakes of the *Natrix rhombifera* complex are discussed on page 53.

Most measurements in the text are in the metric system. Temperatures are expressed

TABLE 7

VARIATION IN THE NUMBER OF LABIALS

Taxon	Supralabials							Infralabials						
	5	6	7	8	9	10	Total	8	9	10	11	12	13	Total
e. alta	—	—	—	221	3	—	224	—	48	107	69	—	—	224
e. bogerti	—	—	—	60	4	—	64	—	14	35	15	—	—	64
e. transversa	—	—	—	263	9	—	272	—	13	184	71	2	2	272
r. blanchardi	—	1	22	187	2	—	212	1	6	91	97	10	—	205
r. rhombifera	—	—	2	132	—	—	134	—	—	11	119	4	—	134
r. werleri	—	—	—	145	3	—	148	—	—	11	109	21	1	142
v. celaeno	1	—	11	252	3	—	267	—	8	259	—	—	—	267
v. isabelleae	—	—	6	103	1	—	110	—	5	95	3	—	—	103
v. thamnophisoides	—	—	6	217	17	—	240	—	7	228	4	—	—	239
v. valida	—	—	6	503	14	—	523	—	12	475	27	—	—	514
v. intergrades[a]	—	—	—	156	5	1	162	—	10	143	9	—	—	162

[a] Intergrades among three taxa: *valida* × *isabelleae* × *thamnophisoides*.

in degrees Centigrade, and measurements taken on animals and depths of rainfall are indicated in millimeters. In the case of elevations, both the metric and English systems are used; the figures reported by the collectors or other persons appear first and their equivalents, read from a table, are indicated in parentheses. Distances included in the lists of locality records are stated as they appear in the various museum catalogues or in publications. The great majority of these are in miles or fractions thereof, inasmuch as they were recorded on the odometers of American-made automobiles.

Unless otherwise indicated, all colors were recorded from live specimens. It was our practice, immediately after the animals had shed, to photograph them (several individuals of each taxon, including juveniles and adults of both sexes) and to record the coloration of various parts of the body, including the eye and tongue, on matte prints made from the appropriate negatives. The names used are those of Ridgway (1912). Most of the color descriptions in the text are largely from our matte prints, but some were derived directly from live specimens.

Many of the names used by Ridgway are self-descriptive, but others are not. In the latter cases I have added a general term for

TABLE 8

VARIATION IN THE NUMBER OF LABIALS ENTERING THE ORBIT

Taxon	3	3+4	4	4+5	5	5+6	4+5+6	None	Total
e. alta	—	—	221	—	3	—	—	—	224
e. bogerti	—	—	58	5	1	—	—	—	64
e. transversa	—	—	71	187	3	2	—	2	265
r. blanchardi	1	—	152	—	1	—	—	22	176
r. rhombifera	—	—	133	—	—	—	—	—	133
r. werleri	—	—	114	1	—	—	—	29	144
v. celaeno	—	—	8	248	—	—	2	—	258
v. isabelleae	—	—	6	106	—	1	—	—	113
v. thamnophisoides	—	—	2	224	—	12	2	—	240
v. valida	—	1	6	485	1	7	3	—	503
v. intergrades[a]	—	—	—	159	—	5	—	—	164

[a] Intergrades among three taxa: *valida* × *isabelleae* × *thamnophisoides*.

TABLE 9

VARIATION IN THE NUMBER OF OCULARS

Taxon	Preoculars					Postoculars					
	1	2	3	4	Total	1	2	3	4	5	Total
e. alta	222	—	—	—	222	3	93	126	—	—	222
e. bogerti	63	1	—	—	64	—	19	45	—	—	64
e. transversa	268	4	—	—	272	—	32	223	16	—	271
r. blanchardi	204	6	—	—	210	—	3	184	24	1	212
r. rhombifera	129	5	—	—	134	—	16	116	2	—	134
r. werleri	29	112	7	—	148	—	—	116	33	—	149
v. celaeno	253	15	—	—	268	3	57	206	2	—	268
v. isabelleae	105	—	—	—	105	—	—	107	—	—	107
v. thamnophisoides	233	7	—	—	240	—	21	217	2	—	240
v. valida	488	32	—	1	521	1	40	482	2	—	525
v. intergrades[a]	153	8	—	—	161	—	9	149	2	—	160

[a] Intergrades among three taxa: *valida* × *isabelleae* × *thamnophisoides*.

the color, such as pale brown, orange-yellow, and so forth, so that reference need not be made to the Ridgway color swatches unless a close approximation of shade or tone is desired. Distinction is made by capitalizing the initial letters of all names from Ridgway and using wholly lower-case letters for all other color names.

Because the pattern features vary, methods of counting blotches or other markings are described under the generalized heading for each individual species.

Tooth counts were obtained from several sources—from skulls, detached dentigerous bones, and examination *in situ* in large preserved specimens, the teeth of which could be exposed by making shallow slits parallel to and directly adjacent to the long axes of the bones. It was then possible to press aside the adjacent soft tissue, which was freed of moisture temporarily by a stream of air directed against it. Counts were made of the number of tooth sockets rather than of the teeth only, because teeth are frequently missing. Tooth counts are given only for the *Natrix valida* complex. Summaries on

TABLE 10

VARIATION IN THE NUMBER OF TEMPORALS

Taxon	Primary Row			Secondary Row				
	1	2	Total	1	2	3	4	Total
e. alta	222	—	222	—	125	97	—	222
e. bogerti	64	—	64	—	21	43	—	64
e. transversa	272	—	272	—	116	149	6	271
r. blanchardi	212	—	212	3	169	40	—	212
r. rhombifera	134	—	134	1	123	10	—	134
r. werleri	122	30	152	—	91	59	1	151
v. celaeno	267	1	268	5	241	19	—	265
v. isabelleae	100	7	107	—	56	52	—	108
v. thamnophisoides	240	—	240	—	130	109	—	239
v. valida	521	1	522	3	399	122	—	524
v. intergrades[a]	162	—	162	1	113	48	—	162

[a] Intergrades among three taxa: *valida* × *isabelleae* × *thamnophisoides*.

TABLE 11

MAXIMUM TOTAL LENGTHS AND HEAD-BODY LENGTHS AMONG MEXICAN POPULATIONS OF *Natrix*

(The measurements are in millimeters. If the largest specimen has an incomplete tail, the total length given in parentheses was calculated with the use of the ratio of the mean total length to the head-body length of the largest complete specimens, usually 10, of the same sex and taxon.)

Taxon	Males		Females	
	Head-Body	Total	Head-Body	Total
e. alta	781	1055	937	(1222)
e. bogerti	708	962	794	1012
e. transversa	750	(1021)	966	1277
r. blanchardi	780	(1056)	1068	1358
r. rhombifera	862	(1141)	1105	1376
r. werleri	791	(1082)	1162	(1486)
v. celaeno	712	955	730	(963)
v. isabelleae	479	(662)	707	(950)
v. thamnophisoides	500	(682)	672	(893)
v. valida	579	774	867	(1136)

dentition in *N. erythrogaster* and *N. rhombifera*, both of which range widely in the United States, are reserved for monographic studies now in progress on those two species groups.

The descriptions of the hemipenes were made chiefly from the everted organs, and the procedures and terms used follow those recommended by Dowling and Savage (1960).

Unless otherwise indicated, all statements and summarizations in the text are based exclusively on samples from the Mexican water-snake populations.

In preparing the synonymies, I have followed the current trend of "streamlining" them instead of attempting to include every known reference as I did in an earlier paper (Conant, 1946, pp. 253–254, 261–262) on the *Natrix valida* complex. In general the following criteria were observed in the compiling of the lists: (1) include original de-

TABLE 12

VARIATION IN THE RATIO OF THE TAIL LENGTH TO THE TOTAL LENGTH, EXPRESSED IN PER CENT

Taxon	Males			Females		
	N	Range	Mean	*N*	Range	Mean
e. alta	57	26–28	27.4	48	23–26	24.6
e. bogerti	12	25–27	26.1	19	22–25	23.5
e. transversa	62	25–28	26.9	63	22–26	24.2
r. blanchardi	45	24–28	26.4	39	21–25	23.5
r. rhombifera	31	22–26	23.9	24	20–22	21.3
r. werleri	30	25–28	26.8	28	21–26	23.4
v. celaeno	51	24–28	26.1	55	23–26	24.7
v. isabelleae	12	27–29	27.5	30	24–27	25.9
v. thamnophisoides	39	25–29	26.4	32	24–27	25.1
v. valida	110	23–28	26.4	96	22–27	24.8
v. intergrades[a]	24	24–29	26.4	31	23–27	24.7

[a] Intergrades among three taxa: *valida* × *isabelleae* × *thamnophisoides*.

TABLE 13

VARIATION IN THE NUMBER OF BODY BLOTCHES AMONG MEXICAN RACES OF *Natrix erythrogaster* AND *Natrix rhombifera*

Taxon	*N*	Range	Mean
e. alta	108	38–46	40.9
e. bogerti	29	33–41	36.8
e. transversa	124	32–45	38.9
r. blanchardi	77	24–35	29.4
r. rhombifera	67	29–41	34.9
r. werleri	68	25–37	30.5

scriptions, all synonyms, and the first paper in which each presently accepted combination appeared; and (2) make no attempt to trace the peregrinations of each species through the succession of generic names to which most forms described a century ago have been subjected.

Climatological data are chiefly from Contreras Arias (1942), and most statements about vegetation in the various parts of Mexico are from Leopold (MS). Although it is clearly recognized that the microhabitats provided by the rivers supporting populations of *Natrix* differ markedly from the surrounding countryside, especially when desert conditions prevail only a few meters distant, a brief statement about the climate and vegetation is included as a matter of general interest in the discussion of each individual taxon.

The sections on Ecology and Natural History were derived largely from my own notes and observations that were made incidental to field work or in our home laboratory or at the Philadelphia Zoological Garden. So little has previously been recorded on natricine snakes in Mexico that I have attempted to include everything that might be of interest to practitioners of the herpetological discipline.

COMMENTS ON LOCALITY RECORDS

Numerous problems were encountered both in the listing and in the plotting of locality records, including misspellings, the delineation of collecting stations in terms of highway route numbers, the listing, at length, of localities stated in tenths of miles from the same settlement, and the use of different criteria by two or more independent collectors in referring to the same site.

Some localities, if accepted literally, would have required plotting records in the Gulf of Mexico, the Gulf of California, or the Pacific Ocean. Most of these involved roads paralleling the coasts, and, although the highway trended north (or south), the localities should have been stated as "northwest," "southeast," and so on, instead of in terms of the cardinal directions. All such errors that I detected have been corrected.

Spellings of place names, which often vary confusingly from one map of Mexico to another, were adjusted to conform either with those appearing on the set of 47 topographic sheets of "La carta geográfica de la República Mexicana de la Ex-Comisión Intersecretarial" (1958) or the millionth maps ("Map of Hispanic America") of the American Geographical Society of New York (published on various dates).

Despite the obvious folly of recording localities solely in terms of highway route numbers, which may suddenly be changed or the roads rerouted, many specimens bor-

TABLE 14

VARIATION IN THE NUMBER OF DARK BODY SPOTS IN A SINGLE ROW AMONG THE RACES OF *Natrix valida*

Taxon	Males			Females		
	N	Range	Mean	*N*	Range	Mean
celaeno	7	80–97	87.3	12	75–92	86.3
isabelleae	1	71	—	10	63–73	66.5
thamnophisoides	10	63–78	72.9	10	64–76	70.1
valida	10	54–82	72.8	10	53–76	67.2

rowed from various museums were accompanied by such unsatisfactory data. Wherever possible I have restated these to indicate the approximate distance and direction from the nearest settlement or important landmark, even though, in some cases, it required considerable correspondence with the collectors to make sure just where they obtained their material. In a few instances I have retained the route number, but only as information supplementary and subordinate to the remainder of the statement on locality.

Herpetological literature is studded with long lists of locality records resembling the following hypothetical ones: 0.2 mile north of Squeedunk, 0.4 mile north of Squeedunk, 0.7 mile north of Squeedunk, 1.1 miles north of Squeedunk, 1.3 miles north of Squeedunk, 1.8 miles north of Squeedunk, 2.4 miles north of Squeedunk, and so on. Precision admittedly may be of importance in ecological studies or in cases in which two taxa intergrade or hybridize in areas marked by sharp changes in the physiographic environment. Most such information, unfortunately, is anything but precise, especially if the distances were recorded during the course of casual road cruising, or if there is no way of determining whether the mileage was measured from the center or northern edge of Squeedunk. To save space I have grouped several such series of nearby localities to read, for example, "0.2 mile to 2.4 miles north of Squeedunk," but only if they are from the same collection and the material originated in regions where the taxon in question is widely distributed.

The most difficult problem was deciding whether two or more apparently different localities are one and the same. For example, most collectors entering the extraordinarily interesting Cuatro Ciénegas *bolsón* in Coahuila for the first time stop along the small stream that flows through the portal at the eastern edge of the valley. This point was indicated, at least in 1962 and 1964, by a roadway sign that read "El Cariño" (for El Cariño de la Montaña, the name of the property owned by the brothers Henrique and Mario Miller). The stream is variously known as the Río Salado, the Río Nadadores, and the Río Salado de los Nadadores. This locality has been recorded by different collectors in the following several ways: "El Cariño, Río Salado de los Nadadores," "Río Salado at El Cariño, 2.5 miles north-northeast of Sacramento," "Río Nadadores at El Cariño de la Montaña," "near Estación Celemánia," and "8 miles west of Nadadores." All of these I have lumped together as one. We are familiar with that area, but among the lists from other parts of Mexico it is probable that some individual localities may masquerade as two that appear to be distinct. I have made adjustments when I was sure. Otherwise I have accepted the localities as they were supplied by the curators of the many museum collections.

Several place names could not be found on any maps available to me. Two main reasons are suggested for their absence:

1. They were stated originally in terms of *ranchos*, *haciendas*, or local names, especially during the early days of zoological exploration in Mexico, and present-day cartographers apparently have no record of them.

2. Names have been changed for one reason or another; as examples, Pesquería Grande is now the Villa de García, Patos is now General Cepeda (Conant, 1968, p. 9), and Ventanas is now Villa Corona (Zweifel, 1956b, p. 22).

I endeavored to trace every puzzling or ambiguous locality, first by consulting many maps and then by writing to the collectors for more specific information or by referring to the field books, if such were available, of persons who are now deceased. Places that could not be found are listed but of course not mapped.

Some localities needed careful scrutiny. For example, two specimens of the *rhombifera* complex in the collection of the American Museum of Natural History (A.M.N.H. Nos. 4293, 4294) bear collecting data stated as "La Palmilla, Jalacingo, Veracruz." Jalacingo is a large town at an elevation of approximately 6500 feet, a highly unlikely place for a member of the *Natrix rhombifera* complex. Fortunately the Museum catalogue furnished clues that, in conjunction with information in the gazetteer prepared by García Cubas (1898, p. 340), established the fact that Palmilla is one of 13 "*rancherias*" of the Municipalidad de Tlapacoyan, the principal

town of which (Tlapacoyan) is in the Cantón de Jalacingo 25.5 kilometers north-northeast of Teziutlán at the foot of the sierra (elevation 462 meters). Doubtless I have failed to correct other such discrepancies, but all obvious ones were checked.

Detailed locality records are indicated on several special maps (maps 3, 5, and 6) and at a smaller scale on three maps of streams in Mexico (maps 1, 2, and 4). In the case of the latter, symbols were plotted on copies of an outline map of the drainage systems of Mexico prepared by the Museum of Zoology of the University of Michigan under the direction of Dr. Robert Rush Miller. This base map was selected because of the close association of snakes of the genus *Natrix* with aquatic environments. The sizes of the symbols employed on the maps have prevented showing every individual locality, and a single symbol, especially on the stream maps, may represent several closely adjacent collecting stations. Also, the symbols are probably sufficiently large to mask some errors that inadvertently resulted from lack of precision in collecting data. Whether distances were measured along a road, which frequently may be a winding one, or whether they were scaled from a map was seldom stated. For practical purposes I have plotted localities as straight-line distances from settlements or check points unless information was available to the contrary. Because maps of Mexico do not agree in all (often many) details, and localities in many instances are printed in the wrong places, I have been forced to make choices in plotting some symbols. I hope in so doing I have not perpetrated any serious errors.

ITINERARY

The field work undertaken in conjunction with this study, and others parallel with it, on semiaquatic species of the genus *Thamnophis*, consisted of 10 collecting trips to Mexico—seven of from one-month to nearly two-months duration each, and three of 11 days or less. The total time aggregated almost exactly a year. During the course of our travels we visited every state and territory in the Republic as well as the Federal District.

Although natricine snakes of the genera *Natrix* and *Thamnophis* were our primary objectives, we obtained a great many other reptiles and amphibians, most of which are now in the collection of the American Museum of Natural History. To indicate something of the scope of the field work, and to aid investigators who may have occasion to use our material, I list the more important localities and insert a number of dates that should facilitate the pinpointing of minor stops, such as where we picked up live or dead specimens on the road. Such verification conceivably may be necessary at some future date in view of the frequent duplication of Mexican place names, such as La Gloria, La Loma, San Juan, and Palmito, to mention a few, and the occasional changing of names of towns to honor a person or commemorate an event. The value of a semi-detailed itinerary came sharply into focus during my attempts to reconstruct the routes of other collectors in Mexico, notably that of Lieutenant Couch (Conant, 1968).

Our several routes, in outline form, were as follows:

1949: Entrance at Nuevo Laredo, Tamaulipas (September 23); numerous localities in Nuevo León, including the Cañon de La Huasteca (near Santa Catarina), Ciénega de Flores, García, Monterrey, Sabinas Hidalgo, and Salinas Victoria; westward through Saltillo to the Río Nazas near the village of La Goma, Durango (September 29 to October 1); return to Monterrey and southward to Tamazunchale, Mexico City, and Acapulco; the Laguna Coyuca, Guerrero (October 8 and 9); Taxco because of illness until October 15; to Mexico City and eastward via Puebla, Córdoba, and Veracruz to the Gulf coast at Alvarado, Veracruz (October 17); return to Mexico City via Jalapa and Puebla; west to Uruapan, Michoacán, and the then active Volcan Parícutin (October 21); return to Mexico City and northward to Tamazunchale, Tampico (October 24 and 25), the Cola de Caballo (Horsetail Falls) near Villa de Santiago, Nuevo León, Salinas Victoria and Sabinas Hidalgo; exit from Nuevo Laredo (October 30).

1954: Entrance at Reynosa, Tamaulipas (May 9) to Monterrey; all field work confined to the state of Nuevo León, at Cañon de La Huasteca, Ciénega de Flores, Cola de Caballo, Sabinas Hidalgo, and Salinas Victoria; exit from Nuevo Laredo (May 17).

1955: Entrance at Tijuana (July 6) and south

to San Quintín; exit from Tijuana (July 8); all localities in Baja California Norte.

1959: Entrance at Nogales, Sonora (June 25); southward with stops at Hermosillo, the Río Mayo at Navojoa, both in Sonora, the Río Fuerte north of Los Mochis, the Río Sinaloa at Guasave, and the Río Culiacán at Culiacán, all in Sinaloa; southward to the upland at Tepic (July 1 to 11); side trips with Tepic as base to the coastal plain of Nayarit at San Blas and Rosamorada; eastward via Ixtlán del Río and Guadalajara to the Lago de Chapala at Chapala, Jalisco (July 12 to 15); north through Tlaquepaque, Lagos de Moreno, Aguascalientes, and Zacatecas (July 16 and 17); the village of Río Florido, Zacatecas, on the Río Aguanaval; Durango (July 19 to 22) with a side trip to Nombre de Dios, Durango; the Río Nazas at La Goma, Goméz Palacio, and Chihuahua; exit from Ciudad Juárez, Chihuahua (July 25).

1960: Entrance at Piedras Negras (August 2) and to San Juan de Sabinas, both in Coahuila; Río de los Nadadores at El Cariño, 2.5 miles north-northeast of Sacramento; to Mexico City via Saltillo, Matehuala, San Luis Potosí, and Querétaro, with side trips to Galeana, Nuevo León (August 6), and El Salto near El Naranjo, San Luis Potosí (August 7); westward through Toluca and Morelia to the Lago de Pátzcuaro (August 14 to 16); northward via the Lago de Cuitzéo, Irapuato, Aguascalientes, and Fresnillo; the Río Aguanaval at Rancho Grande, Río Florido, Río Grande, and west of Fresnillo, Zacatecas (August 19 to 22); northward via Durango, Hidalgo del Parral, and Jiménez (August 26) to Chihuahua; exit from Ciudad Juárez (August 29).

Shipped live and preserved material to Philadelphia and re-outfitted; re-entered at Ciudad Juárez (September 3) and retraced route southward and to the Presas Chuviscar and Chihuahua west of Chihuahua; visited many river habitats, including those at or near Boquillas, Ciudad Camargo, Jiménez, Julimes, and Meoqui, all in Chihuahua, and Villa Ocampo, south of Hidalgo del Parral, in Durango; to Durango with stops along the Río Nazas at the Presa Cárdenas, at El Palmito (September 10 to 12), Abasolo, and Rodeo; Durango basin (September 14 to 16); northward to San Juan del Río, Palmitos, and Rodeo; east at La Zarca, Durango, to the Río Nazas at La Goma (September 18); east and north through Saltillo and Monterrey; exit from Nuevo Laredo (September 23).

1961: Entrance at Nuevo Laredo (August 16); via Monterrey, Saltillo, San Luis Potosí, Lagos de Moreno, and Irapuato to Yuriria, Guanajuato; Lago de Cuitzéo (August 20) and Lago de Pátzcuaro (August 22); southwestward to Colima via Zamora, Jiquilpan, and Tamazula; vicinity of Manzanillo (August 23 to 25); northward through Colima and Ciudad Guzmán, with side trip to vicinity of Tonila, Jalisco; Lago de Chapala near Jocotepec and Chapala (August 28 and 29); via Guadalajara and Magdalena, Jalisco, to Tepic (August 31 to September 3), with side trips to Campostela and San Blas, both in Nayarit; to Mazatlán and boarded a coastwise steamer (September 9). (Since we were told for several days that the ship would sail *mañana*, which it did not, we collected each evening to the north of Mazatlán.) Landed at La Paz, Baja California Sur (September 12), and made the "classic loop" to Cabo San Lucas and return, passing through or collecting also at Agua Caliente, San Antonio, San José del Cabo, and Todos Santos; returned to mainland, disembarking at Topolobampo, Sinaloa (September 22); southward to Mazatlán (September 24); climbed the escarpment over the newly opened mountain road to Durango (September 26 and 27); Río Nazas valley at Palmitos, Rodeo, and the Presa Cárdenas at El Palmito; east and north via Torreón, Saltillo, and Monterrey; exit from Nuevo Laredo (October 4).

1962: Entrance at Piedras Negras, Coahuila (July 4), and to the Río de los Nadadores at El Cariño the same night; Cuatro Ciénegas *bolsón*, Coahuila (July 5 to 9); via Saltillo and Torreón to Río Nazas drainage (July 11 to 21, excluding a side trip July 18 and 19 to Buenos Aires in mountains of western Durango), visiting La Concha, La Goma, Nazas, Peñon Blanco, the Presa Cárdenas at El Palmito, Rodeo, and Santiago Papasquiaro, all in Durango; Río Aguanaval drainage at Sain Alto, Río Florido, and near Rancho Grande, all in Zacatecas; crossed the center of Mexico via Aguascalientes, Querétaro, Pachuca, Tlaxcala, and Puebla to the lowlands of southern Veracruz and Tabasco; vicinities of Cosamaloapán and Tlacotalpán, Veracruz (July 28); to Villahermosa, Tabasco, and Barra de San Pedro y Pablo, Campeche (August 1); returned to Coatzacoalcos, Veracruz, and across Isthmus of Tehuantepec (August 4 and 5); visit to zoo in Tuxtla Gutiérrez, Chiapas; small streams in Pacific drainage of the Isthmus of Tehuantepec; Oaxaca de Juárez (August 9 to 15); side trips with Oaxaca as base, including Puerto Angel on the Pacific coast of Oaxaca; northward via Puebla and Teziutlán, Puebla, to Tampico (August 20 and 21); exit from Matamoros, Tamaulipas (August 24).

1964: Entrance at Matamoros (June 30) and to Padilla on the Río Purificación, Tamaulipas; Tampico (July 1 to 3); to the cloud forest northeast of Teziutlán, Puebla, the desert north of

Zacatepec, Puebla, and the relict lake bed directly east of El Carmen, Tlaxcala (July 7 to 9); southward more or less paralleling the coast through the lowlands to Coatzacoalcos (July 11); roads south from Cárdenas toward Presa Mal Paso and from Villahermosa to Teapa and beyond; to and across the Yucatán Peninsula (July 15 to 21), reaching the Caribbean coast at Puerto Juárez, Quintana Roo; return to Coatzacoalcos (July 23), across the Isthmus of Tehuantepec, and eastward to the Guatemalan border at Ciudad Cuauhtémoc, Chiapas; zoo and museum in Tuxtla Gutiérrez (July 27); streams from Tapanatepec to Tequisistlán, Oaxaca, to Oaxaca de Juárez and nearby Santa María Coyotepec; northward and westward via Izúcar de Matamoros, Cuautla, and Amecameca to Mixquic and Xochimilco, Distrito Federal; Laguna El Rodeo east of Miacatlán, Morelos (August 2 and 3); the large lakes of the southern part of the *altiplano* as follows: Lago de Cuitzéo (August 5 and 6), Lago de Pátzcuaro (August 7 and 8), Lago de Chapala and vicinity (August 10 to 14), Lago de Atotonilco (August 14 to 16), and Laguna de Magdalena, Jalisco (August 18 and 19); northward and eastward via Guadalajara, San Luis Potosí, and Saltillo; Cuatro Ciénegas *bolsón* (August 22 to 24) and San Juan de Sabinas, both in Coahuila; exit from Piedras Negras (August 25).

1965: Entrance at Ciudad Juárez, Chihuahua (June 23); Río Nazas drainage, with stops at El Palmito, Rodeo, and Los Palmitos; Durango and west of El Salto, Durango (June 29 to July 2); Río Aguanaval drainage via Cuencamé, Durango, and Río Grande, Zacatecas, to the Presa Cazadero about 10 miles upstream from Río Grande (July 3); to Jocotepec, Jalisco, via Fresnillo, Zacatecas, Juchipila, and Guadalajara; headquarters at Jocotepec (July 5 to August 2), collecting repeatedly along the shores of the Lago de Chapala and with numerous excursions to other localities, including Magdalena, Jalisco (July 7), Tepic (July 9), Lago de Atotonilco (July 14 and 18), La Huerta, Jalisco (July 21), Tecomán, Colima (July 22), and Laguna de Cajititlán (July 28); eastward and southward via La Piedad and Salamanca to the Lago de Cuitzéo (August 3), Lago de Yuriria (August 4 to 6); Querétaro to Mexico City and eastward via Texcoco and Apizaco to El Carmen, Tlaxcala (August 10); north via Pachuca, Tamazunchale, and Ciudad Victoria; exit from Matamoros (August 13).

1967: Entrance at Ojinaga, Chihuahua (September 6), and to Los Mochis and Topolobampo, Sinaloa. Field work was undertaken near Los Mochis and in the vicinity of Creel, Chihuahua. Exit from Ojinaga (September 15).

All travel was by motor vehicle except that during 1967, which was chiefly by train.

THE GENUS *NATRIX* IN MEXICO

THERE ARE THREE SPECIES of water snakes in Mexico that conform with Malnate's (1960, p. 47) definition of the genus *Natrix*. One is endemic to Mexico, but the other two range widely through the southern United States. The three, with their respective subspecies, are:

1. *Natrix erythrogaster:* This species, the plain-bellied water snake, occurs from the north-central part of the Mexican plateau to the eastern seaboard of the United States, and northward to Iowa, Illinois, Michigan, Ohio, and Delaware. There are three subspecies in Mexico: *transversa* is widespread in streams and other bodies of water of Coahuila, Nuevo León, and Tamaulipas (as well as in Texas, New Mexico, and Oklahoma); and *bogerti* and *alta* are confined, respectively, to the drainage systems of the Río Nazas in Durango and the Río Aguanaval in Zacatecas.

2. *Natrix rhombifera:* The diamond-backed water snake occurs in streams, ponds, swamps, and similar areas of Gulf of Mexico drainage from Alabama and southern Illinois to southern Mexico. Three races are recognized, and all are indigenous to Mexico: *rhombifera* in Coahuila, Nuevo León, and Tamaulipas; *blanchardi* in the Río Pánuco-Río Tamesí drainage complex and a few streams farther north and south; and *werleri* from central Veracruz to the swamplands of Tabasco and also probably well into the adjacent states of Campeche, Chiapas, and Oaxaca.

3. *Natrix valida:* The west coast water snake occurs only in Pacific drainage. The four races are distributed as follows: *valida* in rivers and swamps from southern Sonora to Nayarit; *isabelleae* in the narrow coastal plain from Jalisco to the vicinity of Acapulco, Guerrero; *thamnophisoides* on an outlier of the *altiplano* near Tepic, Nayarit; and *celaeno* in streams of the Cape Region of Baja California.

In brief, one species of water snake (*valida*) lives along the west coast of Mexico, another (*rhombifera*) extends far southward along the east coast, and the third (*erythrogaster*) enters Mexico only in the northeast and in the northern part of the high central plateau.

KEY TO THE MEXICAN FORMS OF *NATRIX*

1. Scales in 19 or 21 rows at midbody (races of *Natrix valida*) 2
   Scales in 23 or more rows at midbody (races of *Natrix erythrogaster* and *Natrix rhombifera*) 5
2. A prominent, pale, middorsal stripe. Nayarit . . . . . *Natrix valida thamnophisoides*
   No prominent, pale, middorsal stripe . . . 3
3. Dorsum gray, or brown, usually with four longitudinal rows of small dark spots. West coast of mainland Mexico 4
   Dorsal pattern variable: (a) as immediately above; (b) dorsum black or dark brown but with a pale, ragged-edged lateral stripe; or (c) variations between these two pattern types. Cape Region, Baja California. . . . . *Natrix valida celaeno*
4. Dorsum usually gray or dull brown and unstriped; ventrals 132 to 150 (mean in males, 141.7; in females, 140.3). Southern Sonora to Nayarit . . . . . *Natrix valida valida*
   Dorsum rich brown in many specimens; lower three rows of scales usually pale in coloration and producing the effect of a pale lateral stripe; ventrals 130 to 138 (mean in males, 134.0; in females, 133.7). Jalisco to central Guerrero. . . . . *Natrix valida isabelleae*
5. Consult chart 1. If characters are those indicated for *rhombifera*, then see. 6
   Consult chart 1. If characters are those indicated for *erythrogaster*, then see 8
6. Dark dorsal pattern prominent 7
   Dorsal pattern subdued or virtually absent; pattern, if distinguishable, largely confined to edges of scales and skin between them. Río San Fernando and headwaters of the Río San Juan southward to the Pánuco-Tamesí and adjacent drainages in Tamaulipas, San Luis Potosí, Veracruz, and Hidalgo . . . . . *Natrix rhombifera blanchardi*
7. One preocular; dorsal pattern usually clean-cut; belly usually marked with numerous,

CHART 1

DIAGNOSTIC CHARACTERS OF MEXICAN *Natrix rhombifera* AND *Natrix erythrogaster*

Species	Under Side of Tip of Tail	Dorsal Pattern (When Present)	Dorsal Scale Rows Anterior to Vent	Infralabials	Chin in Adult Males
rhombifera	Patterned or at least with dark stippling	Dark middorsal cross bars connected by diagonal lines with similar bars on sides of body	Usually 20 or more	11 (occasionally 10 or 12)	With prominent tubercles
erythrogaster	Unpatterned (often reddish or orange in life)	Large, dark, middorsal blotches alternating (but not connected) with smaller blotches on each side	19 or fewer	10 (occasionally 9 or 11)	No tubercles

more or less prominent, semicircular spots. Coahuila, Nuevo León, and Tamaulipas . . . . . *Natrix rhombifera rhombifera*

Two or three preoculars; dorsal pattern dark, not clean-cut in some specimens; dark markings on belly, if present, often small, irregular, or diffused. Southern Veracruz and Tabasco . . . *Natrix rhombifera werleri*

8. Lateral blotches wide,[1] involving one and one-half or more scales (longitudinally); usually two supralabials entering eye; head (in adults) brown or gray, in some cases with a reddish tone. Coahuila, Nuevo León, and Tamaulipas . *Natrix erythrogaster transversa*

Lateral blotches narrow, involving one scale or less; usually one supralabial entering eye. 9

9. General appearance of adults pale and pinkish; lateral blotches very narrow, involving only fractions of adjacent scales and with all dark pigment virtually confined to skin between the scales; head decidedly reddish or orange-brown; usually one supralabial entering eye; young more strongly patterned, with dark gray blotches on a pinkish ground color. Río Nazas, Durango . . . . . *Natrix erythrogaster bogerti*

General appearance of adults dark, including head; lateral blotches one scale wide; one supralabial entering eye; young similar to young of *bogerti*. Río Aguanaval, Zacatecas . . . . . *Natrix erythrogaster alta*

THE MEXICAN SUBSPECIES OF *NATRIX ERYTHROGASTER*

Natrix erythrogaster, one of the most widely distributed species of North American water snakes, is represented in Mexico by three races, two of which are endemic to rivers of interior drainage. The most useful characters for differentiating among the three forms are color patterns, the width of the lateral blotches on the body, the number of scales on the venter (expressed as ventrals minus subcaudals), and whether one or two supralabials enter the eye (chart 2).

DISTRIBUTION

The species as a whole ranges from southern Michigan, southern Delaware, and northern Florida westward to southeastern New Mexico and southward to eastern Durango and Zacatecas (Conant, 1958, map 89).

Among the three races in Mexico (map 1), one, *transversa*, occurs over a wide area and is locally common where suitable habitats are available. The others, *bogerti* and *alta*, are restricted to the Río Nazas and the Río

[1] Gross details of pattern usually may be discerned, even in uniformly colored adults, by submerging the specimen in preservative or by spreading the individual scales apart with the fingers. The skin between the scales usually retains indications of the markings.

Aguanaval, respectively, in the northern part of the Mexican *altiplano*, and they apparently have developed their individual characteristics in isolation. Both river systems have internal drainage. Prior to their manipulation by man, both emptied into arid desert basins labeled, even on some recently published maps, as the Laguna de Mayrán and the Laguna de Viesca, respectively, although they have been dry for a long time.

The collective vertical range of the three taxa in Mexico is from about 300 feet (98 meters) in the lower Rio Grande system to 6700 feet (2042 meters) on the high plain of Zacatecas.

Although *transversa* also occurs in the vicinity of springs and the rare swampy areas (*ciénegas*) of northeastern Mexico, all three are essentially stream snakes that are able to exist in rivers traversing desert or semiarid regions. Many such streams are subject to wide fluctuations in water level, occasional great floods, and frequent (at least partial) desiccation.

The restricted habitat and the distribution of the locality records, including those within the United States, indicate that all three forms are relict where they occur in arid North America, probably as a result of the deterioration in climate following the Wisconsin glaciation or at least since the last pluvial period. *Natrix erythrogaster* obviously had a more extensive range in Mexico at one or more times in the past. There is as yet no evidence to indicate where or when the populations in the two desert rivers (Río Nazas and Río Aguanaval) were in contact with the populations in northeastern Mexico, but isolation occurred sufficiently long ago for both inland races to become well differentiated at the subspecific level.

Size and Proportions

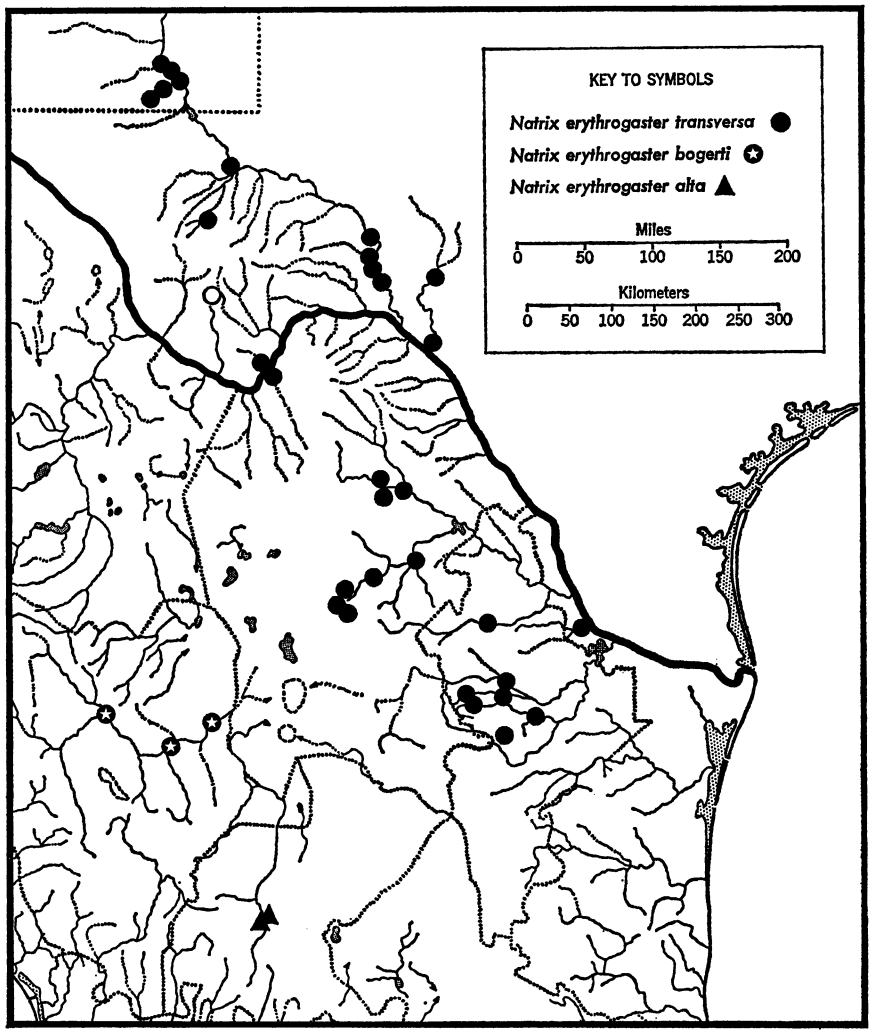
Snakes of this species are relatively stout-bodied, and large females attain greater lengths and girths than adult males. Among the Mexican populations females often exceed 1000 mm. in total length, and the largest, a specimen of *transversa*, measures 1277 mm.; males seldom exceed 1000 mm., but the largest (*alta*) is 1055 mm. The greater girth of females is correlated with: (a) a higher (average) number of dorsal scale rows; and (b) retention of a high number of rows throughout a greater length of the body

CHART 2

Diagnostic Characteristics of the Three Subspecies of *Natrix erythrogaster* Occurring in Mexico

Characteristics	*transversa*	*bogerti*	*alta*
Longitudinal width of lateral blotches (expressed in number of scales)	1½ to 2	1 or less	1 or less
Pattern in adults	Alternating dorsal and lateral blotches on a paler ground color; old adults almost uniformly dark except for pale, dark-bordered lines across middorsal area	General coloration pale pinkish; pattern faint or indiscernible; temporal region strongly reddish	Dark middorsal blotches in strong contrast with pale ground color; old adults almost uniformly dark
Labials entering eye	Usually 2	Usually 1	Invariably 1
Ventrals minus subcaudals			
Males	54–67, mean 59.4[a]	57–62, mean 59.7	49–57, mean 52.9
Females	65–78, mean 71.7[a]	68–79, mean 73.5	66–73, mean 69.0

[a] Specimens of *transversa* from the Río Cañon and other localities within the Cuatro Ciénegas *bolsón*, in Coahuila, are not included.



MAP 1. Stream map showing locality records for the subspecies of *Natrix erythrogaster* in Mexico and Rio Grande drainage in the United States. The hollow circle is for a literature record from Calamity Creek, Brewster County, Texas.

Most snakes of this species have a maximum of 25 dorsal scale rows, and the increase to this number takes place farther anteriorly and the decrease to a lower number occurs farther posteriorly in females, on the average, than it does in males. In short, females have more dorsal scales than males, but the discrepancy between the sexes is not so pronounced as it is among the races of *Natrix rhombifera*.

The head is large, broad, and distinct from the neck. In juveniles the width of the eye is somewhat greater than or approximately equal to the distance from the eye to the nostril; in adults the eye is proportionally smaller, and, except in a few specimens from the Cuatro Ciénegas *bolsón*, it is narrower than its distance from the nostril.

The body, in cross section, is rounded. The tail is relatively long and attains a greater proportionate length in males than it does in females.

Juveniles are proportionally more slender than adults, but are otherwise similar. New-

born young vary from 191 mm. to 283 mm. in total length (table 19).

Scutellation

The dorsal scales are strongly keeled, and most of them bear two apical pits. Faint knobs are discernible on the keels of many of the scales of the anal region in large males. The maximum number of scale rows is usually 25, but a few snakes have as few as 23 or as many as 27. The minimum number of rows is normally 17 or 19, but in the subspecies *transversa* the minimum is 16 in nearly 20 per cent of the snakes of both sexes.

The anal plate, although normally divided, may consist of a single smooth scale or of one scale bearing a groove in the position that normally would be occupied by the suture between the two component parts of the divided anal scute. The incidence of single or grooved anals is high in the population of *transversa* from El Cariño, Coahuila (p. 32). The presence of a single anal plate is also of fairly frequent occurrence in the species *erythrogaster* as a whole; among populations in the United States it occurs in 9.4 per cent of 757 specimens studied, and, if the grooved condition is included, the ratio is even higher (Conant, 1961, p. 15). This anomalous condition should be borne in mind, especially when one attempts to separate members of the genus *Natrix* from those of the genus *Thamnophis*, in which the anal plate normally is single. The frequency of occurrence of single or grooved anals is indicated in the summarizations for each of the three Mexican subspecies of *erythrogaster*.

The number of labials entering the orbit (one or two) is of taxonomic significance, as are the numbers of ventrals and subcaudals.

Coloration and Pattern

All races of *erythrogaster*, including those confined to the United States, exhibit marked ontogenetic variation in coloration and pattern. Juveniles are strongly patterned with three rows of dark dorsal blotches superimposed on a pale ground color (pl. 3, fig. 4, pl. 4, figs. 3, 6, pl. 5, figs, 3, 4, 6). The blotches of the middorsal series are large and in the form of saddles, and they normally extend downward to the seventh or eighth row of scales. The smaller lateral blotches, which usually involve the second to the sixth rows of scales but in some cases also involve the first or seventh rows, alternate with those of the middorsal series from a point near the head to and including the base of the tail. The (longitudinal) width of the lateral blotches is of taxonomic significance among the Mexican races.

As the snakes increase in size and age, the blotches become paler and the ground color darkens, and the pattern grows progressively less conspicuous (less contrasty). Large adults tend to assume a uniform coloration except for traces of pattern that may remain in the form of short, pale, but dark-bordered bars across the center of the dorsum (pl. 3, fig. 6).

The body blotches may be counted with ease among juveniles and subadult specimens, and also among some adults if the latter are submerged in liquid. The number of middorsal blotches was recorded for each countable specimen from the dark blotch at the rear of the head to the last complete blotch anterior to a point directly above the anus, inclusive; split blotches were counted as two if both parts reached the midline of the back or if they were so large as to indicate that two blotches of more or less normal size had fused along one side of the back. No counts were made on the tail; the markings fade out on the base of the tail, and the distal portion may be virtually unicolored.

A pair of parietal spots, consisting of small, white, cream-colored, yellowish, or pale or dusky gray markings, one on each parietal scute but in close proximity to each other, is present in many snakes of this species. In general these markings are most conspicuous in juveniles and least so in adults, but from some individuals they are missing entirely. Similar paired parietal spots are conspicuous in many species of garter snakes of the genus *Thamnophis*. In addition, the several races of *erythrogaster* in Mexico exhibit, often prominently, a pale postparietal streak or spot surrounded by dark pigment. This marking is about a scale in width and one to several scales in length, and it is situated immediately posterior to

the termination of the suture between the two parietals.

Hemipenis

The everted hemipenis may be described as follows: Shaft subcylindrical and ornamented with spines and spinules that diminish in size distally; nude patches at the base adjacent to the basal and accessory hooks. Apex bilobed and nude. Sulcus simple and terminating at the junction of the two lobes. One large basal hook (the free edge 2.5 mm. to 3.5 mm. long in snakes measuring 750 mm. to 1000 mm. in total length) lateral to the sulcus and followed distally by several small spines. An accessory hook on the opposite side of the sulcus, more distal than and smaller than the large basal hook, and followed distally by several small spines.

In situ the hemipenis extends caudally to the seventh or eighth subcaudal, and the M. retractor penis magnus originates on the caudal vertebrae at the level of the twenty-fifth to the twenty-eighth subcaudal.

Geographical Variation

There is a strong tendency for members of populations of *erythrogaster* to be paler in coloration in arid regions than they are in more humid areas. Thus, those inhabiting the Río Nazas (*bogerti*) and those from Trans-Pecos Texas tend to be considerably paler than those from the Río Aguanaval (*alta*) or from eastern Texas.

The variations in the scales of the venter in Mexican populations, expressed as the number of ventrals minus the number of subcaudals, is graphically illustrated in figure 1.

Natrix erythrogaster transversa (Hallowell)

Blotched Water Snake

Plate 3, figures 1–6, plate 4, figures 1–6, plate 5, figure 4

Tropidonotus transversus Hallowell, 1852, p. 177.

Nerodia Couchii Kennicott, 1860, p. 335.

Natrix erythrogaster transversa: E. H. Taylor, 1929, p. 58.

Type and Type Locality

A.N.S.P. No. 5044, holotype, a young adult male collected by Samuel Washington Woodhouse and accompanied by the following data: "Creek boundary, found near the banks of the Arkansas and its tributaries" (Hallowell, 1852, p. 177).

This specimen, which is still in relatively good condition, obviously is the holotype. The numbers of ventrals and subcaudals agree exactly, and the maximum number of dorsal scale rows is 23 except for a short distance (at the level of the forty-first to the forty-ninth ventral) where an extra scale appears between the fourth and fifth scale rows on the left side of the body, resulting in a count of 24 for a short distance. Hallowell reported "a series of subquadrate dark colored blotches thirty-six or thirty-seven in number, along the back." This number is also exact, for the twenty-first blotch is partially split and could be counted as either one or two. Hallowell, however, apparently made his count from the head to and including the last fairly well-defined blotch on the dorsal surface of the tail. There are 33 or 34 blotches from the head to a point directly above the anus, and the two anterior of these are best described as cross bands that descend well downward toward the ventrals; all other dorsal blotches alternate with lateral blotches on each side of the body that average two scales in (longitudinal) width. The type is greater in length than Hallowell stated, for it has a total length of 674 mm. and tail length of 179 mm. in comparison with his "2 ft." and "6 inches" (610 mm. and 153 mm.), respectively. The snake, which is now rather soft, may have stretched after being in preservative for well over a century, but Hallowell's use of what might be called "round numbers" in the English system of measurement suggests that he estimated the total and tail lengths instead of measuring them accurately.

My scale counts for the holotype are: scale rows 23–24–23–21–19–17; ventrals 144; subcaudals 78; supralabials eight, the fourth and fifth entering the eye; infralabials 11 on the left side of the head and 10 on the right; one preocular and three postoculars; one anterior temporal and three posterior temporals.

Another specimen (U.S.N.M. No. 1316) from the same locality and also ascribed to Woodhouse was listed by Cochran (1961,

p. 223) as a "cotype" (=syntype) of Hallowell's *Tropidonotus transversus*. This snake, a male, has 146 ventrals and 84 subcaudals, the total length is greater (758 mm.) than that of the holotype, and the blotches are not countable because the specimen is badly faded. Because Hallowell described only a single specimen, which is readily identifiable with A.N.S.P. No. 5044, the United States National Museum snake cannot stand as a syntype.

There have been at least two attempts to establish an exact type locality for *transversa:* (1) Smith and Taylor (1950a, p. 360) for Tulsa; and (2) Cochran (1961, p. 223) for "near Keystone." Both localities are in Tulsa County, Oklahoma, but there is no evidence to indicate that the holotype was obtained at either one. Little, if anything, is gained by trying to pinpoint the locality, for the Arkansas River approximates what was once the boundary of the Creek Indian Nation for only a relatively short distance. *Natrix erythrogaster transversa*, as well as *Natrix rhombifera rhombifera*, no doubt occurred all along the portion of the river in question as, indeed, both still do today, at least where suitable habitats remain.

Harold A. Dundee, during his graduate student days at the University of Oklahoma in 1948, found a map of the "Creek and Seminole Nations" in the University Library that was published in 1910 by E. Hastain of Muskogee, Oklahoma. From the copy of this sent to me by Dundee, it is clear that the Creek Nation occupied all the present Creek, Hughes, Okfuskee, and Okmulgee counties, most of McIntosh, Muskogee, and Wagoner counties, and all Tulsa County except for its northern panhandle. Only in Tulsa County does the Arkansas River parallel any portion of the former perimeter of the Creek Nation. Between the present communities of Keystone and Tulsa the river flows close to the common boundary of Osage County and the northern side of the westward extension of Tulsa County, and that same line formed the northern limit of the Creek territory. Hallowell's specimens of both *transversa* and *rhombifera* (see p. 55) must have been collected along or near the river between the two towns, a distance (along the stream) that probably does not greatly exceed 20 miles. Unless other information eventually comes to hand, I recommend that the type locality for *transversa* be stated, in terms of present-day localities, as "Arkansas River between Keystone and Tulsa, Tulsa County, Oklahoma."

Comments on the Types of *Nerodia couchii*

As indicated in the synonymy for *Natrix erythrogaster transversa* (p. 26), Kennicott described *Nerodia couchii* in 1860, basing it on two specimens that are still extant in the United States National Museum. These are U.S.N.M. No. 1314 from Santa Caterina (=Santa Catarina) and U.S.N.M. No. 1319 from San Diego, both in Nuevo León. Both snakes are now badly faded and show almost no traces of pattern. U.S.N.M. No. 1319 is a skin but with the head and tail *in situ*. In scutellation both closely match Kennicott's description, and most of the few discrepancies between my counts and his are minor and probably result from differences in interpretation. For example, I count nine supralabials on the right side of the head in U.S.N.M. No. 1314, whereas Kennicott counted eight, and, by making several counts along the body, I obtain a maximum of 25 dorsal scale rows in both animals, whereas Kennicott gave the maximum as 23. Our measurements agree rather closely, if allowance is made for changes that probably have occurred during more than a century of preservation and the fact that one specimen is represented by a skin. I think there is no doubt that these are Kennicott's syntypes. Cope (1900, p. 976) designated U.S.N.M. No. 1314 as the "type" of *Nerodia couchii* but incorrectly ascribed the name to Baird and Girard. Cope (p. 977) also inadvertently transposed the numbers for the two specimens. The bound catalogue at the United States National Museum indicates that U.S.N.M. No. 1314 is from Santa Catarina, and not San Diego (*fide* Cope).

U.S.N.M. No. 1314 probably came from the Cañon de la Huasteca, a place of spectacular beauty that almost certainly would be visited by any naturalist working in the vicinity. Lieutenant Darius Nash Couch, for whom the species was named and who collected both snakes, was in nearby Santa Catarina during April, 1853 (Conant, 1968,

p. 9). Specimens that we obtained in La Huasteca in 1949 and 1954 agree closely with Kennicott's *couchii*. This locality has permanent water, although manipulation of the spring streams by man, as reviewed by Kallman (1964, pp. 514–516), has seriously affected the aquatic and semiaquatic fauna in recent years.

San Diego, which has disappeared from modern maps, was approximately 3.5 kilometers east-northeast of San Juan, Nuevo León (Conant, 1968, p. 8).

Range

In Mexico the blotched water snake is known only from the northeastern states of Coahuila, Nuevo León, and Tamaulipas, but it may also occur in the extreme northeastern corner of Chihuahua (map 1). In the United States it ascends the Pecos River Valley to southeastern New Mexico, and it ranges eastward and northward through Texas, Oklahoma, and Kansas to western Missouri (Conant, 1958, map 89).

All Mexican records are from Rio Grande drainage, with many localities reported from tributaries of the Río Salado and the Río San Juan. Records from along the Rio Grande itself (the Río Bravo del Norte of the Mexicans) are few, and their paucity reflects in part the relative inaccessibility of most of the river except at border crossings where night collecting, the most efficient method of obtaining water snakes, would require advance alerting of authorities on both sides of the International Boundary and obtaining permission from the Border Patrol to enter restricted areas. Probably *transversa* occurs at many places along the Rio Grande, and future collecting may also demonstrate its presence in some of the lesser tributary streams and arroyos, at least in those that have permanent water or that retain a few natural pools or impounded water even during periods of drought.

The apparent absence of *transversa* from the lower valley of the Rio Grande is difficult to explain. Brown (1950, pp. 188–189) listed no localities south of Kingsville, Kleberg County, Texas, and the only record known to me from the literature should be considered as suspect. Wright and Wright (1957, p. 489) depicted several views of a specimen of *transversa* accompanied by the caption "Brownsville, Tex., H. C. Blanchard." The only specimen (C.U. No. 1162) bearing such data in the Cornell University collection, where Wright deposited his material, is actually *N. r. rhombifera* and not the animal portrayed. There may have been an error in recording data, and the locality should be considered as unconfirmed, especially since several persons (Ralph W. Axtell, Pauline James, William A. King, Jr., and Ted Beimler) who are familiar with the fauna of the region, and to whom I addressed personal inquiries, all agree that *transversa* is still unrecorded from the portions of Cameron, Hidalgo, and Willacy counties in extreme southern Texas that collectively are known as "The Valley." On the contrary, the diamond-backed water snake, *Natrix rhombifera*, occurs in several localities of the region (p. 57). Both water snakes probably are absent from the arid region of Kenedy County and the adjacent counties to the west that have many eolian sand deposits and dunes that may serve as barriers to dispersal.

What the situation may be on the Mexican side of the river is unknown, but it seems likely, because *transversa* occurs as far downstream as Mier, Tamaulipas, that it might enter the plexus of irrigation canals that penetrates a large area west and southwest of Matamoros. Obviously this region, which has been grossly neglected by American naturalists who hurry through it on their way south, needs investigation.

There also are no records for *transversa* from the upper part of the Rio Grande (p. 29).

There are numerous records for *transversa* from tributaries of the Río San Juan, in Nuevo León (map 1), just as there are for members of the *N. rhombifera* complex (map 3), but, in the case of *transversa*, only one subspecies is involved instead of two, as in the case of *rhombifera*. Based on currently available information, it is possible to speculate that *transversa* may have penetrated the San Juan system subsequent to the stream capture suggested by the known distributions of *rhombifera* and the fish *Poecilia mexicana* (p. 65); *transversa* is unrecorded from the Conchos-San Fernando system in Tamaulipas. Its apparent absence from the latter

watershed and "The Valley" of extreme southern Texas, in addition to its possible recent appearance in the Río San Juan, makes it tempting to postulate that *transversa* entered the lower portion of the Rio Grande system relatively recently. Attempting to draw conclusions at this time, however, is futile. More collecting is needed, as are studies and interpretations of stream histories of the general region.

The altitudinal range of *transversa* in Mexico varies from perhaps 300 feet (98 meters) near Mier, Tamaulipas, to approximately 2100 feet (640 meters) in the Sierra del Carmen near Boquillas, Coahuila, nearly 2300 feet (700 meters) at García, Nuevo León, and approximately 2600 feet (790 meters) a few miles north of Cuatro Ciénegas, Coahuila.

Excluding specimens from the Cuatro Ciénegas *bolsón*, the locality records and museum numbers for 136 Mexican specimens studied in detail are:

COAHUILA: Boquillas, Sierra Del Carmen (D.A. No. 601); Hermanas (F.M.N.H. No. 47066); Músquiz (F.M.N.H. Nos. 28821–28830); Río Sabinas at Rusias (F.M.N.H. No. 28831); Río Sabinas at San Juan de Sabinas (A.M.N.H. Nos. 85201–85206, 102183, 102184); Río Salado de los Nadadores at El Cariño, 2.5 miles north-northeast of Sacramento or 8 miles west of Nadadores (A.M.N.H. Nos. 85207–85223, 88763–88789, 88902–88914, 89472–89479; K.U. Nos. 80283, 80284; U.M.M.Z. No. 122437).

NUEVO LEÓN: Coñan de la Huasteca, near Santa Catarina (A.M.N.H. Nos. 88950–88953; U.I.M.N.H. No. 37964); 7 miles west of Monterrey (C.M. No. 25796); Ojo de Agua at Apodaca (U.I.M.N.H. No. 78841); Ojo de Agua, 4 miles west of Sabinas Hidalgo (A.M.N.H. Nos. 88916–88948; F.M.N.H. No. 105578); Río Pesquería at García (A.M.N.H. No. 88949); Río Ramos at Allende, 20 kilometers northwest of Montemorelos (T.C.W.C. No. 864)[1]; Río Salinas at Ciénega de Flores (A.M.N.H. No. 88915); San Diego on the Río San Juan, 3.5 kilometers east-northeast of San Juan (U.S.N.M. No. 1319); Santa Catarina (U.S.N.M. No. 1314).

TAMAULIPAS: Mier (U.S.N.M. No. 46582).

Also see page 35 for records from the Cuatro Ciénegas *bolsón* in Coahuila.

Localities in Texas from along the Rio Grande and the Devils River are also plotted on map 1. Records and museum numbers for the specimens on which these are based are as follows:

TEXAS: *Brewster County:* All in the Big Bend National Park. Vicinity of Boquillas (C.A. No. 4859; U.M.M.Z. No. 66025; W.G.D. No. 2217); Hot Springs (U.M.M.Z. No. 114207). *Val Verde County:* Devils River on Howard Fawcett Ranch, 70 miles by road north of Del Rio (A.M.N.H. Nos. 102180–102182); Devils River (A.N.S.P. Nos. 15517–15520).

Records for *transversa* from the Pecos River drainage in New Mexico and Texas are discussed below.

ABSENCE OF *transversa* FROM UPPER RIO GRANDE DRAINAGE

On the basis of present evidence, *Natrix* (including *N. r. rhombifera*) does not occur in the Rio Grande (or its tributaries) above its confluence with Terlingua Creek at the mouth of Santa Elena Canyon in the Big Bend National Park. It is unknown at El Paso where several herpetologists have been active. Smith, Williams, and Moll (1963) listed no *Natrix* in their report on reptiles and amphibians collected during a canoe trip along the Río Conchos in Chihuahua. We devoted two weeks of our own field work in 1960 to the Río Conchos and especially its tributaries, but we failed to find *Natrix* in the Río Chuviscar at several localities near Ciudad Chihuahua, in the Río Conchos near Julimes, Ciudad Camargo, and the Lago Toronto, in the Río San Pedro near Meoqui and Las Delicias, and in the Río Florido near Ciudad Camargo, Jiménez, and near Villa Ocampo. During this period we carried a live *Natrix erythrogaster transversa* with us, and, after interrogating fishermen and boys we met along the streams and getting negative responses from them, we exhibited the water snake. None recognized it, but all were familiar with the semiaquatic *Thamnophis eques megalops*, which apparently

[1] T.C.W.C. No. 864 was erroneously reported by Smith and Laufe (1945, p. 350) as *Natrix rhombifera blanchardi*.

occurs throughout much of the Río Conchos system.

During the spring of 1905 Strecker (1909, p. 14) collected both *transversa* and *rhombifera* in Brewster County, Texas, along Calamity Creek, an intermittent upstream portion of Terlingua Creek that is delineated in some detail on the map of the State of Texas (United States Geological Survey, 1965). In the course of his field work Strecker suffered a personal calamity, injuring himself severely, and, according to Bryce C. Brown (personal communication), he was incapacitated for a long time and his material was stored in crocks instead of being catalogued in the natural history collection at Baylor University. Brown further stated that it was shipped to the "San Diego Academy of Natural Science, which had burned down." The specimens of *Natrix* in question are not now at the Natural History Museum operated by the San Diego Society of Natural History, according to Allan J. Sloan, who is in charge of the collection. Nor are they at the California Academy of Sciences, *fide* Alan E. Leviton, to whom I addressed an inquiry on the chance that the information received by Brown might have been faulty. (The California Academy of Sciences was destroyed by fire in 1906 following the great San Francisco earthquake.)

The chance of obtaining fresh material from Calamity Creek appears to be slight, for its course has frequently been dry during recent years (William G. Degenhardt, personal communication). Milstead (1960, p. 82) failed to find either species along Calamity Creek during field work in 1956 and 1957. It is possible, however, that *transversa* may occur in the lower portion of Terlingua Creek. It was in flood during the summer and autumn of 1966, and was a strong-flowing stream during at least part of the same period in 1967. If populations of *transversa* fail to survive periods of drought, snakes may re-enter Terlingua Creek from the Rio Grande; at least they are known to occur farther downstream near the eastern boundary of the Big Bend National Park (at Hot Springs and near Boquillas). We visited the Hill Ranch along Terlingua Creek northwest of Study Butte on September 19, 1967, and saw numerous small fishes and frogs near a large cottonwood at streamside, but no snakes. Roland H. Wauer reports (personal communication) that trees were once fairly numerous in an intermittent gallery forest along the creek but that they were felled for use in smelting operations many years ago. Terlingua Creek at one time may have resembled some of the streams in northeastern Mexico that have disjunct, tenuous stands of trees along their banks, among the roots of which both *transversa* and *N. r. rhombifera* find food and shelter.

The apparent absence of *transversa* from the Rio Grande system upstream from the Big Bend might be attributed to inadequate collecting, but geological evidence and the distribution of several elements of the herpetological and ichthyological faunas suggest that *transversa* may indeed be restricted to lower parts of the river. For simplicity the terms "upper river" and "upper course" are used in the discussion below to indicate the portion of the Rio Grande that occurs upstream from the mouth of Terlingua Creek.

The history of the Rio Grande, based largely on the papers of King (1935) and Kottlowski (1958), may be summarized briefly as follows: The lower part of the river, from the Sierra del Carmen to the Gulf, probably has flowed in much of its present course since the Eocene. The upper portion is much younger and presumably developed as a result of the uplift of the Rocky Mountains during the Pliocene and Pleistocene and the subsequent much greater rainfall. The upper river, during an early stage, meandered southward from New Mexico into the playa country of northern Chihuahua where remnants of large lakes still exist. Eventually it was captured by arroyos from the Hueco *bolsón* southeast of El Paso where it was temporarily impounded until its rising waters cut through in the direction of Fort Quitman. King (1935, p. 26) suggested that the river filled one desert basin after another, spilling over at low points and eventually establishing drainage to the sea. Uplift of the mountains or faulting while down-cutting was in progress may have aided in the development of the great canyons.

The uplift of the Mexican tableland contributed much water to the river via the Río Conchos, which, like the Rio Grande, cuts

across several mountain ranges that are part of the western spur of the Sierra Madre Oriental, as depicted on the map of the landforms of Mexico (Raisz, 1959). The Conchos and the Pecos are the only tributaries of consequence of the Rio Grande except far upstream and far downstream.

A possible interpretation of the known distribution of *transversa* along the Rio Grande would be to assume that it was long established in the lower river, but worked its way headward after the development of the upper course. Available records indicate that *transversa* has penetrated upstream through Boquillas Canyon and, if the old Strecker record is correct, through Mariscal Canyon, but there is no evidence that it occurs in the Rio Grande beyond the mouth of Terlingua Creek where that stream empties into the river at the outlet from Santa Elena Canyon. *Natrix rhombifera rhombifera* may also have penetrated in the same manner.

Distribution in Pecos River Drainage

Although there are no records for water snakes from the Río Conchos and the upper course of the Rio Grande, *Natrix erythrogaster transversa* is known from numerous localities within the Pecos River drainage system. Specimens that I have examined, with their respective data are:

New Mexico: *Eddy County:* Black River, 4 miles west of Black River Village (P.S.C., C.B.H. Nos. 28, 37); Black River, 11.5 miles northeast of Whites City (U.M.M.Z. No. 122941); Carlsbad (U.S.N.M. No. 32785); 6.5 miles southeast of Carlsbad (D.B.U.N.M. No. 101); 18 miles southwest of Carlsbad (K.U. Nos. 13701, 13875, 13876, 14177–14183); Pecos River, 4 miles east of Malaga (T.C.W.C. No. 24234); Rattlesnake Spring, Carlsbad Caverns National Park (C.C.N.P. No. 2420); Upper Black River, Carlsbad Caverns National Park (C.C.N.P. No. 2077); 7 miles southwest of Whites City (U.M.M.Z. No. 121693).

Texas: *Pecos County:* Pecos River near Sheffield (K.U. No. 82568). *Reeves County:* Pecos (A.N.S.P. No. 12050); Toyah Creek north of Balmorhea (S.R.S.C. Nos. 515, 516); Toyahvale (U.M.M.Z. Nos. 49965–49974); 1.5 miles northwest of Toyahvale (U.M.M.Z. Nos. 67415A, 67415B, 97005); 2.5 miles northwest of Toyahvale (U.M.M.Z. No. 92776). *Terrell County:* Blackstone Ranch, 30 miles south of Sheffield (T.N.H.C. Nos. 8052, 8053, 8069); Chandler Ranch, 30 miles south of Sheffield (T.N.H.C. Nos. 7996, 8028); Dunlap Ranch, 25 miles southeast of Sheffield (T.N.H.C. Nos. 8088, 8456); Hicks Ranch, 25 miles south of Sheffield (T.N.H.C. Nos. 8217, 8218, 8395, 8396); Independence Creek on Chandler Ranch (S.R.S.C. Nos. 102, 219, 220, 530). *Val Verde County:* Pecos River, near Howard Draw, Pandale (K.U. No. 82571).

The Pecos River, unlike the Rio Grande and the Río Conchos in Mexico, crosses no mountains, but follows their eastern side through New Mexico and western Texas. It may have received much of its impetus at the time of the Rocky Mountain uplift, establishing a new direction of drainage (southward instead of eastward), probably beheading headwater tributaries of the Canadian, Brazos, and Colorado rivers and carving a canyon through the Edwards Plateau hundreds of feet deep (King, 1935, p. 258).

The records listed above imply a fairly wide distribution for *transversa* in Pecos drainage, at least formerly. Some of the populations are now relict in this generally arid region, where most of the tributaries are intermittent or supplied with permanent water only at or near a few springs, many of which have been manipulated for use associated with human activities. The distributions of *Thamnophis proximus* (Rossman, 1963, pp. 110, 137) and *Acris crepitans* (Conant, 1958, map 232) parallel, at least in part, the range of *transversa* in this general region, and the Pecos River in New Mexico is inhabited by several more species of turtles (Frederick R. Gehlbach, personal communication) and many more species of fishes (Gehlbach, MS) than is the upper Rio Grande. The occurrence of some of these animals in the Pecos, however, may have resulted from the stream capture postulated by King (1935, p. 258). It is beyond the scope of this paper to speculate on the dispersal of the aquatic and semiaquatic vertebrates of the Pecos-Rio Grande system. It is sufficient to suggest, in view of the evidence available,

that one or more factors may operate (or may have operated) to deter the penetration of *transversa* headward along the upper Rio Grande beyond the mouth of Terlingua Creek, a feat that some species (notably *Trionyx* among the reptiles) have accomplished.

Identification

The chief diagnostic characters of *transversa* in Mexico are the broad lateral blotches, which are one and one-half to two scales in width (in the longitudinal axis of the body), and the normally unpatterned surface beneath the tail, which may be orange or reddish near the tip in life. Ontogenetic variation should be taken into account. Juveniles are strongly patterned with dark blotches (pl. 3, fig. 4), but large adults tend to become uniform brown or gray in coloration (pl. 3, fig. 3), although traces of pattern usually remain in the form of pale, dark-bordered lines across the center of the back (pl. 3, fig. 6).

Usually *transversa* may be differentiated at a glance from *Natrix rhombifera rhombifera*, which occurs sympatrically with it (chart 1), but specimens of either, in which the coloration and pattern are masked by the approach of ecdysis, may be confusing. The under side of the tail is usually strongly patterned in *rhombifera*. Large males of the *rhombifera* complex bear numerous large papillae on their chins; there are no large papillae in either sex in *transversa* or in any other species of North American *Natrix*.

Scutellation

Scale counts in *transversa* (excluding material from the Cuatro Ciénegas *bolsón*) may be summarized as follows: Ventrals in males, 138 to 145, mean 141.2; in females, 137 to 146, mean 142.0. Subcaudals in males, 76 to 87, mean 81.8; in females, 64 to 77, mean 70.0. The anal is divided in most specimens, but there is a high incidence of single and grooved anal plates in the population from El Cariño, Coahuila. Among 68 snakes from that locality, including many adults as well as newborn young, 28 (41.2%) have the anal plate single and 14 (20.6%) have it grooved. There are thus abnormalities in 61.8 per cent of the entire sample from El Cariño. A newborn snake from Pozo de Escobedo, 9 miles south of Cuatro Ciénegas, has a single anal. Grooved anals occur in two specimens from other localities, one from Boquillas and one from the Río Cañon north of Cuatro Ciénegas.

The most frequent scale-row formulas are 23–25–23–21–19 and 23–25–23–21–19–17, but there are numerous variations. A maximum of 25 scales occurs in 77 per cent of the females and 72 per cent of the males; counts of 26 or 27 occur in many females, but no male has more than 25. Lower maximum counts occur in many males and a few females. The minimum number of scale rows is 17 in 27 per cent of the females and 65 per cent of the males; the minimum is 18 among 37 per cent of the females. Minimum counts range from 16 to 19 in both sexes.

Dorsal-scale increases and reductions among four males are:

23 +5, 6 or 5+6 (26–37)—*25* 5+6 or 6+7 (54–74)—*23* 5+6 or 4+5 (81–90)—*21* 4+5 or 5+6 (100–112)—*19* 3+4 (131–135)—*17* (140–142)

Dorsal-scale increases and reductions among four females are:

23 +5 or 6 (19–35)—*25* 5+6 or 6+7 (59–70)—*23* 4+5 or 5+6 (79–85)—*21* 4+5 (102–115)—*19* 3+4 or 4+5 (122–137)—*17* (141–143)

Supralabials eight in most cases, but nine in some counts; infralabials 10 in most cases, but 11 in many, nine in some, and, very rarely, 12 or 13 in others. Almost invariably a single preocular, rarely two; postoculars normally three, but in some cases two or four. Invariably a single anterior temporal; temporals in second row three or two, rarely four. Both the fourth and fifth supralabials enter the eye in 70.6 per cent of the cases, but only the fourth enters in 26.8 per cent; very rarely the fifth or the fifth and sixth may enter, and in two cases the oculars meet beneath the eye, thus excluding the supralabials.

Coloration and Pattern

The general pattern characteristics of adults and young of the subspecies *transversa* are shown in the illustrations on plate 3 (figs. 1–6). Material from the Cuatro Ciénegas *bolsón* is illustrated and discussed separately.

The dorsal and lateral markings in new-

born juveniles are dark gray (Chaetura Drab) to virtually black (Olivaceous Black 3). The dorsal ground color is pale to medium gray, and the lateral ground color is gray or reddish brown. The pale skin between the scales is of several different tints. Between the middorsal blotches it is white to cream-colored; between the lateral markings it varies from reddish brown to pink or Coral Red, and these colors, in conjunction with the reddish brown of the scales themselves, impart a distinctly reddish tone to the sides of the body between the dark markings.

Other features of the coloration in juveniles, based on several captive-born litters and a number of wild-caught individuals, may be summarized as follows: Top of head chiefly black or dark gray, with the dark pigment largely concentrated on the middorsal portions of the parietals and the posterior part of the frontal; the dark pigment usually surrounds several small whitish or yellowish areas, including the parietal spots. Remainder of head tan, gray, or olive; labials cream-colored to buff, the dark sutures between them reddish brown (Russet or Cinnamon-Brown). Tail brown. Under side of head and throat white, cream-colored, or very pale pinkish buff (Tilleul-Buff); venter buff to pinkish (Cinnamon-Buff to Avellaneous), in some cases with a pale yellowish wash down its center, these colors palest anteriorly but becoming stronger on the posterior part of the body and on the under side of the tail; distal one-half to one-third of under side of tail dull orange-brown or pinkish brown (Mikado, Sayal, or Wood Brown); some black pigment on the anterolateral portions of the ventrals. Eye: Pupil black, narrowly ringed by yellow or cream-color; iris olive (Citrine-Drab to Olive-Brown). Tongue: Base pale pink, tips pale gray.

The pattern remains evident even in most young adults, but the markings become paler and the ground color darkens as the snake matures; adults may be nearly uniform in coloration. The general coloration of a large adult female (total length, 1277 mm.) from the Ojo de Agua, 4 miles west of Sabinas Hidalgo, Nuevo León, may be summarized as follows: Entire dorsal surface Buffy Olive but with traces of pattern along the sides of the body (when the skin is stretched) and in the form of poorly defined, pale, but dark-bordered lines across the center of the dorsum. The skin between the scales is black, pale greenish yellow (Primrose Yellow), and buff (Deep Colonial Buff), and these in juxtaposition with one another provide the suggestions of pattern. Posterior half of tail medium brown (Snuff Brown). Top of head Brownish Olive, labials Honey Yellow; sutures between labials black anteriorly and orange-brown posteriorly. Chin and throat white. Venter yellow (Amber Yellow anteriorly and Mustard Yellow posteriorly) and unmarked except that the dorsal ground color slightly invades the anterolateral edges of the ventrals. There is a faint wash of orange at each side of the belly, directly adjacent to the first row of dorsal scales. Under side of tail orange buff (Ochraceous-Buff). Eye: Pupil black, narrowly ringed with yellow; iris Brownish Olive. Tongue: Pinkish gray, tips pale gray.

Two large adults from the Cañon de la Huasteca, near Santa Catarina, Nuevo León (female, 1101 mm., and male, 866 mm., in total length), are similar except that strong traces of the juvenile pattern, although considerably subdued, are still discernible in the male. In this snake the middorsal blotches are Olive-Brown and the lateral ones Buffy Brown. The pale middorsal cross bands, which are chiefly on the skin between the scales, are cream-colored and bordered by dark gray. The skin between the scales on the sides of the body is pale gray. The dorsum of the female, in contrast, is virtually uniform Deep Grayish Olive. The venters in these two snakes are yellow to buff; Maize Yellow for a short distance anteriorly but changing to Antimony Yellow for most of its length in the male, and Ochraceous-Buff throughout in the female. The under side of the tail in the male is strongly orange (Orange-Buff) anteriorly but changes to Cinnamon near the tip; in the female the Ochraceous-Buff of the belly extends onto the base of the tail, but becomes distinctly browner (Ochraceous-Tawny) near the tip.

There are strong tendencies for populations to vary in general coloration from one locality to another. For example, specimens from the Río Sabinas at San Juan de Sabinas have

relatively pale grayish markings, whereas snakes from El Cariño along the Río Salado de los Nadadores are darker and browner, and those from the Cañon de la Huasteca are dark grayish olive.

The number of dark middorsal body blotches in Mexican populations of *transversa* (excluding material from the Cuatro Ciénegas *bolsón*) varies from 32 to 45, mean 38.9.

Size and Sex

The 10 largest females have the following measurements: head-body length, 966 mm. (total length, 1277 mm.); 943 mm. (1069+ mm.); 907 mm. (1164 mm.); 856 mm. (1101 mm.); 801 mm. (1040 mm.); 689 mm. 898 mm.); 686 mm. (890 mm.); 681 mm. 898 mm.); 675 mm. (880 mm.); and 664 mm. (885 mm.). Comparable measurements for the 10 largest males are: 750 mm. (946+ mm.); 736 mm. (992 mm.); 709 mm. (969 mm.); 703 mm. (954 mm.); 701 mm. (965 mm.); 681 mm. (937 mm.); 659 mm. (788+ mm.); 655 mm. (891 mm.); 638 mm. (866 mm.); and 630 mm. (868 mm.).

Among 82 captive-born juveniles the total-length measurements varied from 191 mm. to 283 mm. (table 19), and the means, calculated separately for each of the six litters involved, varied from 227.8 mm. to 263.3 mm. Only two juveniles of comparable size were collected in the field, and these had total lengths of 240 mm. (a male from Boquillas) and 247 mm. (a female from El Cariño); both localities are in Coahuila.

The sex ratios among the captive-born young were 41 males to 43 females. Males predominated in three of the litters, and females in the other three.

Tail length/total length ratios for males of all sizes are 0.25 to 0.28, mean 0.269; for females, 0.22 to 0.26, mean 0.242.

Populations from the Cuatro Ciénegas *Bolsón*

The town of Cuatro Ciénegas de Carranza, Coahuila, approximately 50 miles by road nearly due west from Monclova and 150 miles south-southeast of the southern tip of the Big Bend of the Rio Grande, is situated near the northern edge of the intermontane basin that bears its name. This *bolsón*, which is roughly 24 miles from east to west and 18 miles from north to south, is bilobed, with the two unequal halves separated in part by the Sierra de San Marcos. Drainage was internal until it was manipulated by man; water now flows through the eastern portal of the basin via canals and the Río Salado de los Nadadores.

Information has been accumulating during recent years on the extraordinary endemism that is manifest in the fauna of the Cuatro Ciénegas *bolsón*, especially among the fishes, turtles, and snails. Webb and Legler (1960), Legler (1960), Minckley (1962), Webb, Minckley, and Craddock (1963), Miller and Minckley (1963), Hubbs and Miller (1965), and Dwight W. Taylor (1966) have all described various parts of the *bolsón* and commented in various ways on its unique fauna. More recently Minckley (in press) has reviewed the physiography, geology, and hydrography of the basin, but, in brief, the salient features of the area, in terms of habitats for aquatic and semiaquatic organisms, are as follows: Springs and streams (pl. 12, figs. 1, 2), fed by underground aquifers, are numerous in several parts of the otherwise arid *bolsón*. Many, with their attendant marshes, had long been isolated from one another until the construction of canals that began about 1898. Recent and continuing proliferation of the canal system, in part to supply water to the steel mills of Monclova, has greatly altered some of the spring pools, destroyed or relocated marshy areas, and, of prime concern to students of evolution and speciation, has permitted previously isolated populations to establish contact with others, resulting in the development of hybrid swarms, at least among some of the fishes.

Because of the endemism among the other groups of animals, the samples of *Natrix*, which are meager from most localities within the basin except from the Río Cañon, have received special attention during the present study. Water snakes of both the *erythrogaster* and *rhombifera* complexes occur in the basin, as does also the equally semiaquatic garter snake *Thamnophis proximus diabolicus*. Locality records and museum numbers for 36 specimens of *Natrix erythrogaster* from the *bolsón* are as follows:

COAHUILA: Cuatro Ciénegas (F.M.N.H. No. 47067); 9 miles south and 5.5 miles west of Cuatro Ciénegas (R.W.A. No. 3142); 6.8 miles southwest of Cuatro Ciénegas (A.S.U. No. 8439); El Mojarral, 6.9 miles southwest of Cuatro Ciénegas (A.S.U. Nos. 8436, 8437); Juan Santos Laguna, 8.5 kilometers south and 8 kilometers west of Cuatro Ciénegas (A.S.U. No. 8434); Ojo de Agua de Tío Candido, 13 miles south of Cuatro Ciénegas (U.C.M. No. 25037); Pozo de Escobedo, 9 miles south of Cuatro Ciénegas (A.M.N.H. Nos. 89469–89471); Pozos de la Becerra, 10 miles south-southwest of Cuatro Ciénegas (A.S.U. No. 8433); Río Cañon, 1 to 3 miles north of Cuatro Ciénegas (A.M.N.H. Nos. 88757–88762, 93814–93817; A.S.U. Nos. 8512–8516; C.M.Nos. 42796–42800; U.C.M. Nos. 25038–25040); Río Mesquites marshes, 6 miles southwest of Cuatro Ciénegas (A.S.U. No. 8435); Río Mesquites marshes, 5 miles south-southwest of Cuatro Ciénegas (A.S.U. No. 8438).

As these records indicate, there is a good sample from the Río Cañon, which flows through a wooded canyon north of Cuatro Ciénegas, but each of the other localities listed, which are in the flat, virtually treeless basin, is represented by only one or two specimens with one exception. An adult female from the Pozo de Escobedo gave birth to two young, and there are thus three individuals from that locality.

There are some suggestions of local endemism among these snakes, at least in coloration and pattern, but the smallness of the samples from each separate locality precludes any attempt to evaluate them objectively. Ontogenetic changes and minor variations in pattern that normally are a part of all populations of *transversa* require that sizable series, preferably of fresh material, be available for analysis. Because of the intense interest that taxonomists of several different disciplines are currently showing in the fauna of the Cuatro Ciénegas *bolsón*, it probably will be only a matter of time until their field work produces many more water snakes with precise locality data. It seems advisable, therefore, to be conservative until more material becomes available, and I am tentatively placing all members of the *N. erythrogaster* complex from the basin in the subspecies *transversa*. Several specimens from the vicinity of Cuatro Ciénegas are illustrated on plate 4, and data derived from studies made on the total available sample from the *bolsón* appear on the following pages and in figure 1.

Because such vagile reptiles as water snakes are not restricted to the water as are fishes and aquatic snails, there probably was limited gene flow between local populations even before the first canals were dug. Two of the specimens of *Natrix* were found away from water on roads of the region. A specimen of *rhombifera* was collected 3 miles east of Cuatro Ciénegas and one of *transversa* 6.8 miles southwest of that town. The latter snake, according to unpublished field notes kindly made available to me by Mr. William S. Brown, was encountered after a storm. On August 29, 1965, there was a relatively heavy rain in that usually arid region. Precipitation was steady for about an hour and caused dirt roads to become impassable in the general vicinity, which is near the northern tip of the Sierra de San Marcos. The snake was collected the following day. Marshes are numerous but are separated by dry flats in that general part of the *bolsón*. Brown, in conjunction with his studies on the endemic turtle *Terrapene coahuila*, engaged in two months of daily field sampling in a series of 11 shallow marshes about 10 kilometers southwest of Cuatro Ciénegas in July and August, 1965, and during the entire time he encountered only two water snakes in that area. His response to finding them in the marshes was one of surprise, and it is his impression that they had wandered into the study area from other localities, either by traveling overland during or after periods of rain or by following water channels that are numerous at or below the surface in a large part of the basin.

Indications that *N. r. rhombifera* also wanders into the desert, probably stimulated by rains, was obtained during our own field work in Nuevo León, and the locality data for two other specimens (p. 62) suggest similar wandering.

The development of the canal system has now, of course, opened innumerable highways for *Natrix* and other semiaquatic and aquatic organisms, and movements from one

formerly isolated *pozo* to another must be relatively frequent. Also, snakes from El Cariño, at the eastern portal of the *bolsón*, theoretically may now penetrate westward along the canals, and snakes from within the basin may swim or float outward on the strong current. The populations within the *bolsón* and those just outside its eastern edge are no longer isolated from each other.

Variation in the Population from the Río Cañon

Minckley (in press) has described the Río Cañon, which flows for a distance of 7 kilometers in the Cañon del Agua around the eastern shoulder of the Sierra de la Madera in a roughly southeastward direction and serves as the water supply for the town of Cuatro Ciénegas. The canyon is well wooded and supports many large trees, shrubs, and, in more xeric situations, desert plants of numerous varieties. Pools and riffles are well developed. All the specimens were collected in or close to the stream from 1 to 3 miles north of Cuatro Ciénegas.

Variation in scale counts (these are not included in the tables) in this material (14 males and 10 females) may be summarized as follows: Ventrals 134 to 137, mean 135.2 (males); 134 to 138, mean 136.7 (females). Subcaudals 81 to 86, mean 83.5 (males); 69 to 76, mean 72.6 (females). Maximum number of dorsal scale rows, usually 25 in both sexes, but 23 in one male, 26 in two females, and 27 in another female; minimum number 17, 18, or 19. Supralabials eight in all cases, except in one snake on which there is a count of nine on one side of the head; infralabials usually 10, but varying from nine to 12. A single preocular, except that there are two on one side of the head in one specimen; postoculars usually three, but in some cases two. A single anterior temporal in all, except one snake that has two on one side of the head; secondary temporals usually three, but in some cases two. Two supralabials, the fourth and fifth, usually enter the eye, but in four specimens only the fourth enters on both sides of the head.

In coloration and pattern, snakes from the Río Cañon (pl. 4, figs. 1–3) fall within the range of variation of the subspecies *transversa* in Mexico in general.

Variation Among Samples from the Flats of the *Bolsón*

The general characteristics of the *pozos* and streams of the two broad lobes of the Cuatro Ciénegas *bolsón* have been described by Minckley (in press). Many of these were long isolated, and presumably supported their own small demes of water snakes that received gene imports only as a result of occasional wandering by individual specimens. There is some suggestion that the colorations and patterns of the plastic *transversa* may vary from one *pozo* or stream to another, but the samples are much too small for one to be certain. No large concentrations of water snakes, such as occur at El Cariño and several other localities in northeastern Mexico, have been encountered within the floor of the *bolsón*, and it may take some time to accumulate sufficient material to answer such questions as: Is there one or more recognizable taxon confined to the *bolsón*? What is the relation of the snakes from the two lobes of the basin floor to those in the Río Cañon on the northern perimeter of the basin? What relation do the snakes of the *bolsón* bear to the population at El Cariño at the eastern portal?

Variation in the scale counts (these are not included in the tables) among snakes from the basin floor (eight males and four females) may be summarized as follows: Ventrals 132 to 141, mean 136.5 (males); 138 to 143, mean 140.5 (females). Anal plate single in one newborn juvenile. Subcaudals 79 to 87, mean 82.1 (males); 70 and 71, mean 70.7 (females). Maximum number of scale rows usually 25, but 23 in two, 24 in one, and 27 in another (all these variations are in males); minimum number usually 19, but 17 in two. Supralabials eight in all; infralabials normally 10, but there are also counts of 11 and nine. A single preocular, except that there are two on both sides of the head in one snake; postoculars normally three, but in some cases two. Invariably a single anterior temporal; secondary temporals three, occasionally two. Two supralabials, the fourth and fifth, enter the eye with one exception; only the fourth enters on one side of the head in one specimen.

In some individuals the dark dorsal and

lateral markings are distinctly brown, whereas in others they are dark gray. In the only live adult from the basin floor that I have seen, and which I collected personally in the canal leading north from the Pozo de Escobedo, the dorsal markings are Warm Sepia on a ground color of pale buffy brown. Whether the snakes from individual demes are consistently brown, gray, olive, or some other color is unknown and probably can be

TABLE 15

VARIATION IN VENTRAL AND SUBCAUDAL COUNTS, NUMBER OF BODY BLOTCHES, AND TAIL-LENGTH PROPORTIONS IN POPULATIONS OF *Natrix erythrogaster transversa* IN MEXICO

Subject and Locality	Sex	No. of Specimens	Mean	Range
Ventrals				
Cuatro Ciénegas *bolsón*[a]	♂	8	136.5	132–141
	♀	4	140.5	138–143
Río Cañon[b]	♂	14	135.2	134–137
	♀	10	136.7	134–138
El Cariño[c]	♂	34	140.2	138–143
	♀	34	140.5	137–145
Northeastern Mexico[d]	♂	32	142.4	139–145
	♀	31	143.6	140–146
Subcaudals				
Cuatro Ciénegas *bolsón*	♂	8	82.1	79–87
	♀	3	70.7	70–71
Río Cañon	♂	13	83.5	81–86
	♀	10	72.6	69–76
El Cariño	♂	31	81.7	77–86
	♀	32	68.9	64–76
Northeastern Mexico	♂	31	82.0	76–87
	♀	31	71.2	64–77
Ventrals minus subcaudals				
Cuatro Ciénegas *bolsón*	♂	8	54.4	48–61
	♀	3	70.0	67–72
Río Cañon	♂	13	51.5	49–55
	♀	10	64.1	62–68
El Cariño	♂	31	58.4	54–64
	♀	32	71.4	65–78
Northeastern Mexico	♂	30	60.5	55–67
	♀	31	72.1	67–78
Body blotches				
Cuatro Ciénegas *bolsón*	—	12	42.1	37–48
Río Cañon	—	24	38.9	33–45
El Cariño	—	68	40.6	33–45
Northeastern Mexico	—	56	36.8	32–45
Tail length/total length				
Cuatro Ciénegas *bolsón*	♂	8	0.291	28–30
	♀	3	0.247	24–25
Río Cañon	♂	13	0.292	28–30
	♀	10	0.256	24–26
El Cariño	♂	31	0.272	25–28
	♀	32	0.244	23–26
Northeastern Mexico	♂	31	0.266	25–28
	♀	31	0.240	22–26

[a] Includes several springs, canals, and other localities in the virtually treeless flats of the Cuatro Ciénegas *bolsón*.
[b] A small stream in a wooded canyon north of the town of Cuatro Ciénegas.
[c] El Cariño de la Montaña on the Río Salado de los Nadadores, 2.5 miles north-northeast of Sacramento, Coahuila.
[d] All other localities in Coahuila, Nuevo León, and Tamaulipas are lumped together.

determined only by a careful examination and recording of colors from live specimens. Subtleties of patterns also need to be studied.

Comparisons of Mexican Populations of *transversa*

For purposes of comparison the Mexican snakes of the *Natrix erythrogaster transversa* complex have been separated geographically into four groups, as follows: (1) several localities in the virtually treeless flats of the Cuatro Ciénegas *bolsón;* (2) the Río Cañon; (3) El Cariño de la Montaña at the eastern portal of the Cuatro Ciénegas *bolsón*; and (4) all other localities in northeastern Mexico (in the states of Coahuila, Nuevo León, and Tamaulipas). Ventrals, subcaudals, ventrals minus subcaudals, body blotches, and tail length/total length ratios among these four groups are compared in table 15, and differences in ventrals minus subcaudals are shown graphically in figure 1.

From these data it is apparent that the lowest ventral counts, the highest subcaudal counts, and the longest tails occur in the deme from the Río Cañon. Snakes from the flats of the basin (group 1), however, do not conform in general with either the Río Cañon population or with the populations from outside the *bolsón*; in various respects they are close to one group or the other. Also, as stated above, snakes from isolated springs

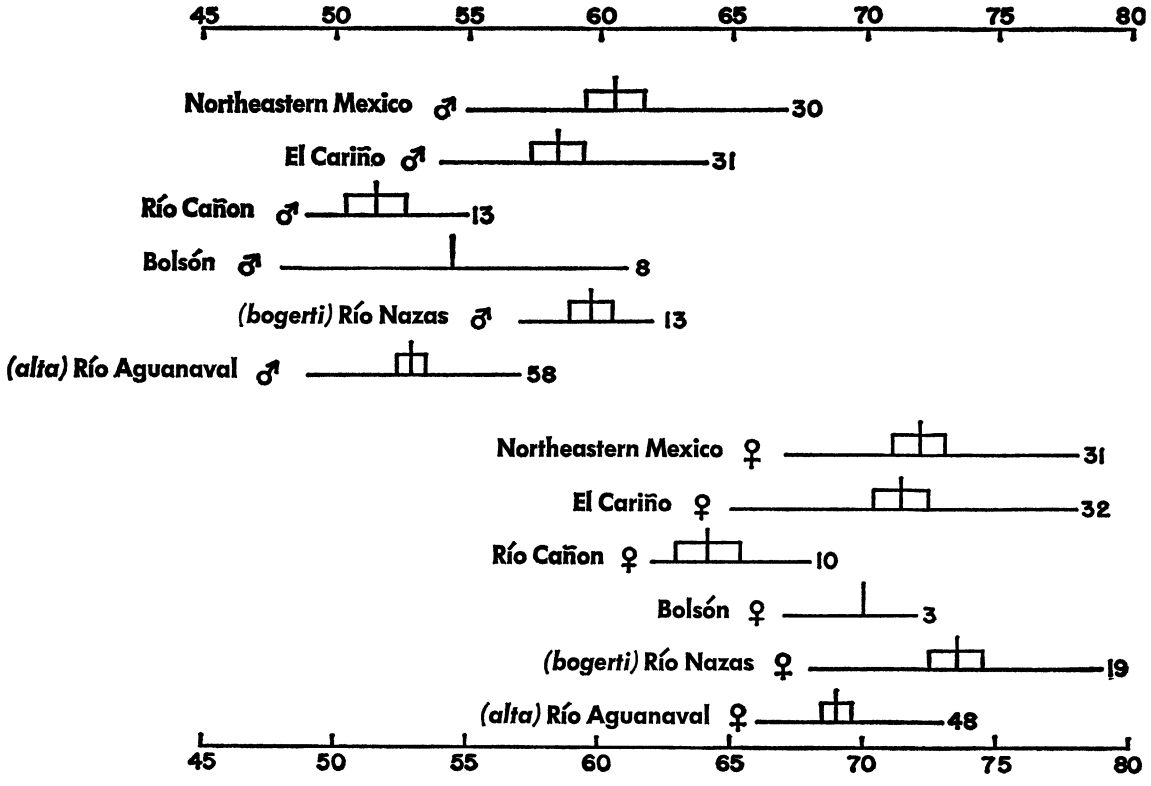


FIG. 1. Ventral scales minus subcaudal scales among populations of the *Natrix erythrogaster* complex in Mexico. The horizontal bar indicates the range of variation in each sample; the vertical bar, the mean; and the rectangle, two standard errors of the mean on each side of the mean. The number of specimens comprising each sample is indicated at the right side of each individual graph. The several populations are grouped as follows: (1) northeastern Mexico, all specimens from Mexico with the exception of those from the Cuatro Ciénegas *bolsón* and its eastern portal; (2) El Cariño, all material taken in the Río Salado de los Nadadores at the eastern portal of the *bolsón*; (3) Río Cañon, the sample from the small wooded stream north of Cuatro Ciénegas; and (4) *bolsón*, all material from scattered *pozos* and streams on the floor of the otherwise arid basin. Data for the subspecies *bogerti*, from the Río Nazas, and *alta*, from the Río Aguanaval, are included for comparative purposes.

and other areas on the basin floor may vary in coloration and pattern from snakes from other isolated bodies of water. The sample currently available is much too small for meaningful comparisons, and whether any of the separate, isolated populations, including the one from the Río Cañon, deserve taxonomic recognition cannot be decided until more material becomes available from the flats of the *bolsón*.

The data for the subspecies *transversa* that appear in tables 1–3, 5, 7–13 were derived from snakes of the complex from outside the *bolsón*. Thus, groups 3 (from El Cariño) and 4 (from numerous localities in northeastern Mexico) were combined. The observed ranges and means of both groups approach each other closely, and the only outstanding difference between them is the very high incidence of single or grooved anal plates in the El Cariño population.

Ecology and Natural History

The portion of Mexico inhabited by *transversa* is characterized by its aridity and hot summer climate. Most of the area falls within the mesquite-grassland zone of Leopold (MS), but this taxon also occurs within the borders of the Chihuahuan Desert. Mean annual temperatures are 21.8° C. at Monterrey and 24.0° C. at Montemorelos, both in Nuevo León, but late spring and summer temperatures may reach 44° C. at interior localities, such as Cuatro Ciénegas and Sabinas, both in Coahuila. Rainfall within the Mexican range of *transversa* varies from an annual total of 135 mm. at Cuatro Ciénegas, where this meager amount is more or less evenly distributed from May to December, to 718 mm. at Monterrey, where there is a peak in September with an average of 205 mm., followed by October, the second rainiest month, with 110 mm. (Climatological data from Contreras Arias, 1942.)

The larger streams of the region may continue to flow during the dry season or they may desiccate to or beyond the point where standing water remains only in isolated water holes. The latter are usually situated where the swift currents, during periods of flood, cut into banks or gouge away softer parts of the stream bed. In any event the water table remains sufficiently close to the surface during the driest periods to support a fringe of cottonwoods, willows, or cypresses. Shrinking water holes in such localities often contain concentrations of water snakes and other aquatic and semi-aquatic organisms, with the snakes basking among the lower branches during the mornings, retreating to holes among the roots during the heat of the day, and prowling abroad in the evening in search of food.

Most of the specimens of *transversa* were collected in or along the edges of rivers and streams, but there were exceptions, notably in the marshes and *pozos* of the Cuatro Ciénegas *bolsón*. Others were found in the outflows of large springs in several localities. Probably *transversa* occurs in most of the streams of the region, but the majority of these snakes were caught in shallow watercourses with or without emergent vegetation, where it is easiest for collectors to search and maneuver, especially at night.

Some of the habitats are greatly restricted in size, attesting to the relict nature of the distribution of water snakes in arid Mexico and their survival in oases, a number of which have been even further reduced by human activities (see pp. 125–127).

An individual of *transversa* (F.M.N.H. No. 47066) collected by E. G. Marsh in April, 1939, at Hermanas, Coahuila, bears data reading "from water below hot spring, 41° C." Schmidt and Owens (1944, p. 101) reported on specimens of *Rana pipiens berlandieri* from Hermanas that came from "the irrigation ditch carrying warm water from the hot spring 'Ojo Caliente' whose waters are at 44° C.," and this is probably the same locality. It is possible that both the snake and the frogs took refuge in the water only temporarily in their efforts to escape from the collector.

Among the many specimens obtained in various Mexican localities, only a few of *transversa* were encountered during daylight hours. Two of these were found by overturning stones or other hiding places at streamside and a few others were either basking or prowling.

There appeared to be a definite correlation between temperature and activity. Two large specimens were caught and another was seen during the cloudy afternoon of September 26,

1949, as they crawled between small spring-fed streams on the floor of the Cañon de La Huasteca near Santa Catarina, Nuevo León. Three others were stretched out on branches in fairly dense vegetation overhanging the main canal to the village. The temperature did not exceed 26° C. at any time during the afternoon, and there were a few light rain showers. On other visits to the same canyon on hot, cloudless days during 1949, 1954, and 1960, when the maximum temperatures were 35° to 38° C., no individuals of *Natrix* were seen, except an adult that was lying submerged in a shallow, rocky pool at dusk. One *transversa* was found stretched out in a tree over a water hole in the almost dry Río Pesquería near the Villa de García, Nuevo León, on a humid, cloudy afternoon, and another was seen prowling in the Río Nadadores at El Cariño, Coahuila, just before dark. In contrast to the relatively few snakes seen by day, series of specimens were collected at night at several localities and on many different dates, usually after hot days. Our notes include mid-afternoon, air-temperature readings varying from 25° to 40° C. Water temperatures are summarized on page 128 for all Mexican forms of *Natrix*.

Our field experience with *Natrix erythrogaster* in the United States parallels our observations in Mexico. Snakes of this species are apt to be seen basking or on the prowl during daylight hours when the weather is cool to moderately warm, as, for instance, during early spring (in Ohio, Michigan, and Virginia), after the passage of cold fronts (in Louisiana, Texas, and Nuevo León), during the early morning hours after cool nights (in Texas), and at high altitudes (in Zacatecas). On the other hand, according to our data, snakes of this species (including members of all six races) are almost exclusively crepuscular or nocturnal during hot weather. Thus, it is difficult to reconcile Milstead's statements (1960, p. 82) with our own observations. He reported a relict population of *Natrix erythrogaster transversa* in western Texas as predominantly diurnal, and suggested that this showed "a habitat change in adaptation to life on the Chihuahuan Desert." Milstead presented no data on temperatures to substantiate his claim, nor did he consider the possibility that fluctuations in weather conditions might influence the behavior of these water snakes. We have collected many specimens of *Natrix erythrogaster*, of the subspecies *transversa* and *bogerti*, in Coahuila and Durango, respectively, within the limits of the Chihuahuan Desert as defined by Milstead (*ibid.*, fig. 1), and virtually all of them were taken at night after hot days. In the higher altitudes of the Chihuahuan Desert in Zacatecas, where the nights are cool, all except one of our many specimens of the subspecies *alta* were collected during morning daylight hours. Milstead further speculated that "competition with *Ancistrodon contortrix* at Independence Creek [Texas] may have influenced the adoption of diurnal habits by *Natrix erythrogaster*," but he offered no reasons for reaching such a startling conclusion.

Specimens of *transversa* taken in Mexico at night were almost invariably close to shelter of one form or another. Many were prowling at the edge of streams, either in the water or close to the bank, and a considerable number were submerged in aquatic or emergent vegetation, with only their heads exposed. Others were in the stonework of small dams or among rocks along banks or stream beds. Only two were found on shallow riffles in open rocky streams, a favorite lurking place for *N. r. rhombifera*. Our general impression, based on collecting series of *transversa* and *rhombifera* together at more or less the same times and places in several localities in Mexico, is that *rhombifera* is more apt to expose itself completely at night. One exceptionally large pregnant female of *transversa*, however, was caught at about 9:00 P.M. as it swam across a fairly deep open pool in the run below the Ojo de Agua west of Sabinas Hidalgo, Nuevo León. Apparently *rhombifera* shuns heavily shaded streams flowing between well-wooded banks, a type of habitat in which *transversa* sometimes occurs.

Natrix rhombifera rhombifera is very often associated with *transversa*, and a comparison of their distributions (maps 1 and 2) and locality records clearly indicates that the ranges of the two are coextensive over a considerable area in northeastern Mexico. Members of the *rhombifera* complex occur throughout a large part of the Gulf coastal

plain, however, and their collective range extends several hundred miles south of the southernmost locality for *transversa*.

Another common associate of *transversa* is *Thamnophis proximus diabolicus*. The two were collected together in the Cañon de La Huasteca in Nuevo León, and in two localities in Coahuila, along the Río de Los Nadadores at El Cariño and along the Río Cañon north of Cuatro Ciénegas.

Probably most kinds of fishes and frogs and some species of toads are eaten by *transversa*. Specimens held captive for varying periods of time consumed a variety of food. An unusual feeding incident, witnessed in my office where I kept a few study specimens alive, involved a young adult female of *transversa*, and it suggested that dead and desiccated food may occasionally be accepted. It was our practice to feed the snakes with freshly killed *Rana pipiens*, placing the latter over the edges of the water dishes with their bodies hanging down on one side and their legs on the other. In this instance the frog was inadvertently allowed to remain in the same position for two days, and, because the office was very warm and dry, the frog changed into a mummy-like cadaver. It was in that condition when the snake started swallowing it head first, but the engulfing process slowed abruptly when the jaws reached the sharp angle that the frog's body formed with its legs. The entire process required nearly an hour, and the snake's abdomen was abnormally distended until (presumably) digestion was well advanced. The bulge had disappeared three days later, and the snake lived in captivity for nearly two years afterward.

A pair of snakes collected along the Río Sabinas near San Juan de Sabinas, Coahuila, on August 2, 1960, exhibited indications of sexual activity. According to my notes for the date, "the male was slowly following the female, and, when I pinned her down first, she moved her tail rather rapidly, and the male became quite excited, following her tail and remaining oblivious to my presence."

Several litters of young were born in captivity (table 19), and the widely scattered dates (July to November) suggest a long breeding season or the possibility that individual females may bear two litters in a single year, as reported for the ribbon snake, *Thamnophis proximus diabolicus* (Conant, 1965b, pp. 140–141).

Natrix erythrogaster bogerti Conant

NAZAS WATER SNAKE

Plate 1, figure 1, plate 5, figures 5–7

Natrix erythrogaster bogerti CONANT, 1953, p. 1.

TYPE AND TYPE LOCALITY

A.M.N.H. No. 73163, holotype, an adult female collected September 29, 1949, in the Río Nazas, near La Goma, approximately 15 miles by road southwest of Ciudad Lerdo, Durango.

RANGE

This race of *Natrix erythrogaster* is known only from the Río Nazas (map 1), a relatively large stream of interior drainage that rises in the Sierra Madre Occidental along the western border of the *altiplano*, crosses the Chihuahuan Desert, and formerly emptied into the Bolsón de Mayrán in southwestern Coahuila. For a description of the Río Nazas system, see Conant (1963c, pp. 475–476 and fig. 1).

All records for *bogerti* are from the state of Durango, but, prior to the impoundment of the river water for irrigation and innumerable other uses in the Laguna District, which includes the cities of Torreón, Gómez Palacio, and Ciudad Lerdo, this snake probably also occurred in Coahuila, including perhaps in or near the sump depicted by Goldman (1951, pl. 44). Despite repeated efforts to establish a "range" for this form by searching in various localities along the Nazas and its tributaries, only two stations are known, as indicated below. I can, however, add a definite "sight" record for the river less than a mile below the Presa Cárdenas, which dams the stream where the Río de Ramos and the Río del Oro unite to form the Nazas. This locality, which is near the village of El Palmito, Durango, is indicated by the westernmost star on map 1. Unsuccessful efforts were made to find *bogerti* at or near Abasalo, Ciudad Lerdo, La Concha, Rodeo, Palmitos, San Juan del Río, San Rafael, and Santiago Papasquiaro, all of which are on the Río Nazas or one of its tributaries. In response to queries, natives

along the Río Nazas at Rodeo and near Abasalo and along a southern tributary, the Río de San Juan at Palmitos, all described a large, relatively heavy-bodied water snake. They were then shown a living adult of *transversa* that we were carrying with us, and they agreed they had seen similar but considerably paler snakes along the rivers near their homes. In all probability *bogerti* ranges widely through the Nazas system.

The known altitudinal range of *bogerti* varies from 3800 feet (1158 meters) at La Goma and 4100 feet (1250 meters) at Nazas to 4700 feet (1433 meters) at the Presa Cárdenas near El Palmito.

The locality records and museum numbers for the 32 specimens examined are:

DURANGO: A three-mile portion of the Río Nazas centered on the point where the Torreón-Durango highway (Mexico No. 40) crosses the river near La Goma approximately 15 miles by road southwest of Ciudad Lerdo (A.M.N.H. Nos. 67300, 73163–73170, 89449–89457; B.C.B. Nos. 9720, 9721); Río Nazas at Nazas (A.M.N.H. Nos. 89458–89468, 96937).

There is also a sight record from near El Palmito (see above).

IDENTIFICATION

This subspecies is characterized by its pale, pinkish coloration, the distinctly reddish tone of the temporal region, and the reduction of the lateral blotches to narrow vertical bars (chart 2). Juveniles are similar to those of the subspecies *alta* but are paler and with less contrast between the markings and ground color. There are also average differences in the numbers of ventrals, subcaudals, and supralabials entering the eye (tables 1, 2, and 8).

SCUTELLATION

Scale counts in *bogerti* may be summarized as follows: Ventrals in males, 141 to 145, mean 143.1; in females, 143 to 148, mean 145.2. Anal plate divided in all specimens, except one in which it is grooved. Subcaudals in males, 82 to 85, mean 83.4; in females, from 68 to 76, mean 71.6.

The most frequent dorsal scale-row formula is 23–25–23–21–19, but the maximum number of rows is fewer than 25 in half the specimens, with most of the lower counts occurring in males; the minimum number is most often 19, but there are reductions to 18 or 17 a short distance anterior to the anal region in many specimens. Scale increases and decreases among four males are:

23 +6 or 5 (30–54)—*24* 5+6 or 6+7 (33–68)—*23* 4+5 or 5+6 (82–99)—*21* 4+5 (101–110)—19 (143–145)

The increase from 23 to 24 rows among these four snakes and among other males is highly irregular. In general, in any one specimen the increase to 24 occurs for only a few rows of scales, and rows may drop out and then reappear, in some cases in several areas, farther posteriorly on the body. In two of the four males an extra row appears only on the right side of the body. In another a twenty-fourth row appears for a short distance on the left side of the body, but then drops out and a twenty-fourth row appears on the right side farther posteriorly. In the fourth snake the scale rows are erratic; scales are added or dropped at random, and it is possible to obtain a total of 25 in a few places by counting obliquely in such a manner as to pass through a brief twenty-fourth row on one side of the body and then through an equally brief twenty-fourth row on the other.

Scale increases and decreases among four females are:

23 +6 or 7 (27–42)—*25* 5+6 or 4+5 (51–72)—*23* 5+6 or 4+5 (86–99)—*21* 4+5 (104–114)—*19* (143–147)

In contrast to the condition occurring among males, the changes in females are fairly regular, but even in some of them the number of scale rows is reduced erratically from 25 to 24.

Supralabials almost invariably eight, but nine on both sides of the head in two females; infralabials 10 in most instances, but 11 or nine in several others. Preocular almost invariably a single scale, but divided into two parts, an upper and a lower, on one side of the head in one snake; postoculars three or two. In most instances the lowermost postocular extends well forward beneath the eye and permits only a single supralabial to enter the orbit; rarely two supralabials may

enter. Invariably one anterior temporal; secondary temporals three or two.

Coloration and Pattern

The dorsal view of the head, a lateral view at midbody, and a ventral view at midbody of a young adult female are illustrated in color (pl. 1, fig. 1). The colors shown are typical of large specimens of both sexes of *bogerti*.

In a series of newborn juveniles from Nazas, Durango, the general appearance of the dorsal ground color in life was whitish between the middorsal blotches and Cinnamon-Drab between the vertical bars, but these apparent colors actually consisted of the following components: all dorsal scales were light grayish brown (Drab), but in the middorsal region their edges and the skin between them were white; on the sides of the body the skin between the scales was Coral Red.

Other features of the coloration in the same litter may be summarized as follows: Top of head chiefly Deep Grayish Olive, but with slightly paler areas on some of the cephalic plates; a prominent light (almost white) postparietal spot about two scales long and one scale wide; labials chiefly cream-colored, but with orange-brown along the sutures between them. Tail dull reddish brown (Natal Brown), with a slightly darker, stripelike area on the proximal half of its middorsal surface. Under side of head and throat cream-colored; venter dull pinkish (Vinaceous-Buff) washed with dull olive (Citrine-Drab) along the center of its length, basal half of under side of tail pinkish brown (Wood Brown), distal half slightly darker (Fawn Color). Eye: Pupil black, narrowly ringed with yellow; iris medium brown (Bister). Tongue pale orange above, pale gray below; tips medium gray.

The strongly contrasting pattern that is evident in newborn individuals of *bogerti* becomes more subdued almost at once. In a wild-caught snake that measured 300 mm. in total length and, to judge from its size, was not more than several weeks of age, the dark markings (pl. 5, fig. 6) were still strongly evident, but they were not so dark nor was the ground color so pale as among the litter of young described above. In a larger juvenile (a male 384 mm. in total length) that was caught on July 11, 1962, the pattern was subdued (pl. 5, fig. 7), and the scales of the dorsum were pinkish brown (Wood Brown), a tint that matches the coloration of many fully grown adults.

In adult specimens the contrast between the markings and the ground color is greatly reduced; the only really dark pigment (dark gray to almost black) is on the skin between the scales within the borders of the narrow vertical markings on the sides of the body.

The general coloration of two large adults from near La Goma, Durango, may be summarized as follows: Dorsal markings pale dull brown (Saccardo's Umber) to pinkish brown; lateral markings similar but slightly paler. Dorsal ground color paler pinkish brown. Top of head Grayish Olive, the temporal region washed with reddish brown (Vinaceous-Rufous or Russet). Belly a delicate blend of yellow and pinkish; center of belly Primrose Yellow in one snake and Ochraceous-Buff in the other, flanked by Pinkish Buff or Light Pinkish Cinnamon along the lateral edges of the ventrals. Under side of tail similar but richer; Cinnamon on the distal third to half. Eye, as a whole, noticeably darker than head; pupil black, narrowly ringed by gold; Iris Grayish Olive in one snake and orange-brown heavily washed with gray in the other. Tongue pink at the base, washed with gray dorsally; tips gray.

The coloration in several other adults, for which notes were recorded, varied little from the two described in some detail above.

Some large adults are virtually uniform in coloration on their dorsal surfaces. For example, the holotype (A.M.N.H. No. 73163) was almost plain pale pinkish brown (Wood Brown) when first captured. It was then thin, but, during the several months it was maintained alive in captivity, it fed voraciously and soon developed a fairly strong pattern (pl. 5, fig. 5). The change resulted from an increase in the girth of the body; the individual scales remained Wood Brown, but, as the snake gained weight and the scales stretched apart, the pattern elements on the skin between them were exposed.

The obscuration or exposure of the hidden

colors, as tested in the field at a later date, is responsible for an apparent variation in intensity of pattern among large adults under natural conditions. The pattern is fairly strong if the animal is plump, if it inflates itself with air, or if it is held so that a convex coil of the body is exposed to the viewer. It is weak or virtually absent if the snake is thin, its lung is deflated, or a concave surface of a coil is examined. Strongly injected preserved specimens also tend to show considerable pattern.

There is relatively little variation in coloration among the entire series of 32 specimens, if proper allowance is made for changes associated with age.

The number of body blotches in the mid-dorsal row varies from 33 to 41, mean 36.8.

Size and Sex

The six largest females have measurements as follows: head-body length, 794 mm. (total length, 1012 mm.); 714 mm. (940 mm.); 643 mm. (858 mm.) 643 mm. (829 mm.); 601 mm. (774 mm.); and 583 mm. (764 mm.); Comparable measurements for the four largest males are: 708 mm. (962 mm.); 632 mm. (848 mm.); 594 mm. (806 mm.); and 539 mm. (736 mm.).

Among nine juveniles that were born in captivity on October 8, 1962, the total length measurements varied from 230 mm. to 246 mm., mean 235.9 mm. (table 19). The sex ratio among the litter was four males to five females. Among six juveniles collected near La Goma, Durango, during the period from September 29 to October 1, 1949, inclusive, total lengths varied from 245 mm. to 300 mm.; the smallest of these falls within the range of variation of the snakes of the captive-born litter.

Tail length/total length ratios for males of all sizes are 0.25–0.27 (0.261); for females, 0.22–0.25 (0.235).

Ecology and Natural History

The Río Nazas derives most of its water from the precipitation that occurs at higher elevations in the watershed drained by its tributaries. These, in part, are in pine-oak forest, but much of the course of the river is through mesquite-grassland, and it traverses desert near its mouth (Leopold, MS). The lower river valley is characterized by high summer temperatures, mild winters, and meager rainfall, which is concentrated from late May to October. The annual precipitation is only 312 mm. at the town of Nazas and 244 mm. at Ciudad Lerdo. Mean annual and maximum recorded temperatures (the latter in parentheses) were listed as 21.2° C. (43.6° C.) and 21.3° C. (40.8° C.) at the same two stations, respectively, by Contreras Arias (1942).

Only 23 specimens of this form have been collected, and we were fortunate to obtain 20 of them ourselves. With the exception of one apparently newborn individual, all of ours were taken at night among water-rounded stones, in shallow stony riffles, or in brush piles along the Río Nazas. Small fishes were abundant in or near all such places. Frogs and toads were few, probably because of a paucity of suitable breeding places in the arid environs of the river. Exceptions were at Rodeo where there are several small, semipermanent ponds parallel to the river and where *Rana pipiens* is abundant, and at El Palmito where there are marshy seeps and pools among the rocks short distances from the river.

The flow of water in the Río Nazas, between La Goma and La Loma, where most specimens were taken, is subject to great fluctuation even though the large dam upstream near El Palmito now permits considerable control. The river is crossable on foot at numerous places during the dry season (pl. 13, fig. 2), but it sometimes becomes a torrent (pl. 13, fig. 1) after summer rains fall in the headwaters to the west and northwest. The snakes must be adjusted to these changing conditions, for a riffle or stony shingle may be exposed one night and under a foot or more of rapidly flowing water the next. At the town of Nazas I caught three specimens along a narrow stony shelf at the water's edge at the foot of a precipitous earthen bank. The next morning, after a local rain, the shelf was submerged and a fairly strong current of water was flowing over it. These snakes probably use holes in the bank or among the roots of trees as diurnal refugia, but many taken at night at the type locality were 100 yards or more from the nearest elevated site that could

provide shelter in the event of sudden severe flooding. Either the snakes must travel considerable distances across the shingle and associated mud bars to reach suitable feeding sites, or they must find hiding places closer to the water but which were not apparent to our eyes. When the water level is stabilized, as it is at the end of the rainy season, larger snakes, at least, appear to have specific hiding places to which they retreat when alarmed. During our visit to La Goma in 1949, three were pursued repeatedly over the same route on three different nights. Two eventually were caught.

The juvenile found during daylight hours was in a small stone pile at the water's edge along with two large adults of *Thamnophis rufipunctatus*. Turning stones anywhere along the Río Nazas was largely unproductive, partly because the stones are heated rapidly by the sun during daylight hours and partly because their water-worn, rounded surfaces provide few suitable hiding places. It is probable that individuals of *bogerti* bask on willow branches overhanging the river, for residents of villages along the Nazas reported occasionally seeing large snakes in such places, and, unless they all exaggerated the size of *Thamnophis eques megalops*, which I both observed and collected in such habitats, they probably saw *Natrix*. *Thamnophis melanogaster canescens* was also taken at both localities where *bogerti* was obtained.

At Rodeo, 6 miles north of Rodeo, and near Abasalo, at all three of which localities many hours were spent in fruitless search for water snakes, broad stony shingle alternates irregularly with steep mudbanks at times of low water. During high water few, if any, stones are exposed. If the snakes occur in these localities, and they probably do, they may dry themselves by climbing into the willows that line large portions of the riverbanks, thus perhaps accounting for the reports of basking snakes.

Feeding may be at a minimum during periods of high water because of the disturbance of the aquatic fauna, whereas a drop to more normal levels may serve as a stimulus to foraging. Some evidence in support of this supposition was obtained July 11, 1962, at La Goma when eight individuals of *bogerti* of assorted sizes were found actively moving about shortly after dark. The condition of the mud flats indicated the river had subsided considerably within the preceding 24 hours, making available a wide expanse of apparently suitable foraging areas that had been under water the previous night. Three other snakes were found the following night at Nazas under similar conditions. All our other specimens of *bogerti* were collected only after many hours of search, and on several nights we found none at all.

The Río Nazas supports an intermittent gallery forest, which is a conspicuous feature of the otherwise arid Chihuahuan Desert through which it flows. The forest consists of willows and cottonwoods that grow fairly densely in some places but only tenuously in others. Seldom is the "gallery" more than two or three trees wide. Near the mouth of the river, and especially in the wide floodplain between La Goma and La Loma, rows of trees mark the location of former main channels. Below the Presa Cárdenas near El Palmito the gallery forest (pl. 14, figs. 1–2) consists chiefly of ancient cypress trees (*Taxodium*). It was while working slightly farther downstream along a high bank among these giants that the sight record was made on September 11, 1960. An adult snake, estimated to be nearly 3 feet in length, swam into the beam of my headlamp some 8 or 10 feet below me, paused long enough for its pinkish coloration and reddish head to confirm its identification, and then swam rapidly away. Although I worked at the same locality on numerous occasions during the months of June, July, August, and September over a period of several years, I never saw another *Natrix* there. The manipulation of the water level for the benefit of agricultural and industrial purposes downstream makes it far from an ideal watersnake habitat, although the Río Nazas is now subject to far fewer fluctuations than it was prior to the construction of the Presa Cárdenas. Large *túneles* at the base of the dam permit the discharge of water in great quantities on demand, such as during the growing season, and the effects of floods from upstream during the rainy season can be largely negated.

During our visit to the area directly below the Presa Cárdenas on September 10 and 11,

1960, large swarms of the characin *Astyanax fasciatus mexicanus* were in evidence in shallow areas along the stream and in all pools and seepage runs in direct contact with the river. Thousands of dead and dying fish lined the shorelines, and their presence attracted many birds. On the morning of September 11 we counted 68 common egrets, two wood ibises, a great blue heron, several cormorants, and many black and turkey vultures. Most of them were resting in the cypress trees, but others were feeding at the water's edge. Any hungry water snake could have stuffed itself to capacity in a matter of minutes.

We suspected that the characins might have been migrating upstream and were stopped by the dam. Robert Rush Miller examined a small series we collected and ruled out the possibility of a breeding migration.

Only one litter of *bogerti* was born in captivity, and data for it are included in table 19. Judged from the sizes of the six juveniles collected near La Goma from September 29 to October 1, 1949, inclusive (see p. 44), they probably were born within a few days prior to their capture.

Natrix erythrogaster alta Conant

AGUANAVAL WATER SNAKE

Plate 3, figure 8, plate 5, figures 1–3

Natrix erythrogaster alta CONANT, 1963b, p. 169.

TYPE AND TYPE LOCALITY

A.M.N.H. No. 84152, holotype, a young adult male collected July 19, 1959, in a section of the Río Aguanaval (known locally as the Río Florido) at the village of Río Florido, approximately 15 miles northwest of Fresnillo, Zacatecas. An unfortunate transposition of digits on page 169 in the paper describing this taxon needs correction. The paratypes reported as A.M.N.H. Nos. 85320–85322 are actually A.M.N.H. Nos. 85230–85232.

RANGE

This race of *erythrogaster* is known only from the Río Aguanaval (map 1), which is variously designated in upstream portions of its course as the Río Nieves, Río Trujillo, Río Medina, and Río Florido. This is a river of internal and, in some parts of its length, intermittent drainage that rises in the highlands of west-central Zacatecas, flows northward across the Chihuahuan Desert, and emptied into the now dry Laguna de Viesca in southwestern Coahuila prior to the diversion of its water for agricultural and other purposes. Presumably there was formerly a confluence with the Río Nazas, which may have been through a gap east of the Sierra de La Peña utilized by the railroad connecting Torreón with Saltillo (see map in Jones, 1938, p. 72). (For a description and map of the Río Aguanaval drainage system, see Conant, 1963c, p. 476 and fig. 1.)

Whether *alta* is widely distributed along the Aguanaval and its tributaries remains to be demonstrated. At present, material is at hand from only two localities that are relatively close together, but, judged from the appearance of the gallery forest and other habitats available along the river, it probably occurs at least from a point a few miles upstream from the village of Río Florido to beyond the vicinity of the town of Río Grande. We failed to find it during a brief stop at Río Grande in 1960, which was marred by a flash flood that precluded any attempt to hunt along the river. Nor did we encounter it at three other localities: (1) the Presa Cazadero, approximately 10 miles upstream from Río Grande; (2) about 23 miles west of Fresnillo; and (3) in a tributary of the Aguanaval, the Río Sain Alto at the town of the same name. Boys at the Presa Cazadero clearly described a large, dark brown, aquatic snake, which they often saw in the river below the dam, and which undoubtedly was *alta*.

The known altitudinal range of *alta* is 6500 to 6700 feet (1981 to 2042 meters), the highest elevations at which members of the genus *Natrix* have been collected to date in the New World.

The locality records and museum numbers for the 113 specimens examined are:

ZACATECAS: Río Florido, 15 to 16 miles northwest of Fresnillo (A.M.N.H. Nos. 84151, 84152, 85230–85232; U.M.M.Z. Nos. 118398–118400, 123259); Río Medina near Rancho Grande (A.M.N.H. Nos. 88954–89056, 93193).

Identification

Snakes of this race can be distinguished from *bogerti* by their dark coloration and the retention of pattern elements in subadults that are particularly noticeable when the snakes are swimming. Large adults tend to become uniformly brown or olive-brown in coloration. The lateral blotches are seldom more than one scale in width, and only a single supralabial enters the eye (chart 2). In *transversa* the lateral blotches are usually one and one-half or more scales in width, and two labials usually enter the eye. Differences in the number of ventrals minus the number of subcaudals are also of diagnostic value (fig. 1).

Scutellation

Scale counts in *alta* may be summarized as follows: Ventrals in males, 138 to 143, mean 140.0; in females, 140 to 144, mean 142.1. Anal plate divided in all specimens, except one in which it is grooved. Subcaudals in males, 84 to 90, mean 87.1; in females, 69 to 76, mean 73.0.

Dorsal scale-row formula usually 23–25–23–21–19, but with the maximum number occasionally only 24 in males and often increased to 26 in females; minimum number usually 18 or 19, but often 17, especially in males. Scale increases and reductions among four males:

23 +5 or 6 (29–40)—*25* 6+7 or 5+6 (54–65)—*23* 5+6 or 4+5 (80–89)—*21* 4+5 (99–106)—*19* (139–140)

Scale increases and reductions among four females:

23 +6 (23–29)—*25* 5+6 or 6+7 (58–69)—*23* 4+5 or 5+6 (87–100)—*21* 4+5 (107–113)—*19* (142–143)

Supralabials eight, rarely nine; infralabials 10 in most cases, but 11 or nine in some counts. Invariably a single preocular; postoculars three, in many cases two, rarely one. The lowermost postocular extends forward beneath the eye and permits only a single supralabial to enter the orbit (the fourth, except in those few cases in which the count is nine, then the fifth supralabial enters). Invariably a single anterior temporal; temporals in second row two or three.

Excluded from all the summaries above is an abnormal juvenile (A.M.N.H. No. 93193) that, among other aberrancies, has only 133 ventrals (Conant, 1965b, p. 142, where it was erroneously cited as A.M.N.H. No. 93913).

Coloration and Pattern

The dorsal and lateral markings in newborn juveniles are dark gray to virtually black (Olivaceous Black 1 to Chaetura Black), but the lateral blotches are so narrow that they are best described as vertical bars (pl. 5, fig. 3). The dorsal ground color varies from Grayish Olive to Citrine-Drab. The pale skin between the scales is of several different tints. Between the middorsal blotches it is white; along the edges of the lateral bars it is pinkish buff; in the broad areas between the lateral bars it is reddish, varying from Vinaceous-Rufous in some individuals to Coral Red in others, and this bright coloration may encroach onto the anterior edges of the lateral scales, especially on the neck. Within the vertical bars the skin between the scales is black.

Other features of the coloration in juveniles, based on a large series of captive-born young and one wild-caught juvenile, may be summarized as follows: Top of head with a blackish area involving most of the middorsal portion of the parietals and the posterior part of the frontal, the dark pigment surrounding several small whitish or yellowish spots, including the pair of parietal spots; remainder of head tan (Isabella Color) to Light Brownish Olive or Grayish Olive; labials cream-colored or buffy, the dark sutures between them brown to Chestnut-Brown. Tail dark reddish brown (Vandyke Brown), in some cases with an Iron Gray, stripelike area on the proximal one-half or more of its middorsal surface. Under side of head and throat white to cream-colored; venter white anteriorly to grayish white posteriorly and washed with an orange-yellow tint (Ochraceous-Buff to Warm Buff), this coloration faint anteriorly, but becoming stronger on the posterior part of the belly and on the under side of the tail; distal one-half to one-third of under side of tail reddish brown or orange-brown, varying from Fawn Color in some individuals to Kaiser Brown in others; some black pigment on the anterolateral portions of each of the ventrals. Eye:

Pupil black, narrowly ringed with yellow; iris Brownish Olive to Chestnut-Brown. Tongue pink above, paler on its under surface; the forked portion of the tongue pale gray.

The dorsal markings remain dark and strongly conspicuous even in young adults, and they are especially prominent when a snake is undulating rapidly, as when swimming, and the lighter coloration of the skin between the scales contrasts strongly with the dark markings as the animal flexes its body.

In larger snakes the ground color darkens and the blotches become paler until the colors no longer are in strong contrast with one another, and the dorsal surface may be virtually uniform gray or brown (pl. 5, fig. 1). The coloration of two large adults (a male and a female) from the Río Medina near Rancho Grande, Zacatecas, may be summarized as follows: Middorsal surfaces Brownish Olive; sides of body Light Brownish Olive; areas between the lateral bars Buffy Olive; tail brown (Buffy Brown to Olive-Brown); top of head nearly uniform dark brown (Sepia in the male and between Dark Olive and Clove Brown in the female); labials dull olive (Citrine-Drab), the sutures between them Chestnut. Under side of head nearly white; belly pale dull orange (Honey Yellow in the male and Yellow Ocher in the female), the bases of the ventrals slightly darker; under side of anterior one-half of tail similar to belly; tip of under surface of tail Cinnamon in the male and Ochraceous-Tawny in the female. Eye: Pupil black, narrowly ringed with yellow (orange-yellow in the male); iris Isabella Color washed with Buffy Olive in the male, Citrine-Drab in the female. Tongue pink at base, flecked with gray or brown; tips dark gray.

In the smaller, and presumably younger, type specimen (A.M.N.H. No. 84152) fairly strong indications of pattern are still evident. Its coloration (see Conant, 1963b, p. 171) was somewhat paler and richer in general than that of the two larger (presumably fully adult) individuals described above.

There is relatively little variation in coloration among the entire series of 113 specimens if proper allowance is made for changes associated with age.

The number of body blotches in the middorsal row varies from 38 to 46, mean 40.9.

Size and Sex

The eight largest specimens are all females with measurements as follows: head-body length, 937 mm. (total length, 1115+ mm.); 883 mm. (1133+ mm.); 878 mm. (1035+ mm.); 868 mm. (1126+ mm.); 853 mm. (1113 mm.); 850 mm. (1105 mm.); 823 mm. (1064 mm.); and 815 mm. (1072 mm.). Comparable measurements for two large males are 781 mm. (1055 mm.) and 659 mm. (900 mm.).

Among 93 captive-born juveniles, the total length measurements varied from 223 mm. to 280 mm. (table 19), and the means, calculated separately for each of the six litters involved, varied from 255.9 mm. to 274.1 mm. Only one juvenile was obtained in the field. This, a female (A.M.N.H. No. 89054) caught at the Río Medina dam near Rancho Grande, Zacatecas, on July 22, 1962, measured 263 mm. in total length.

The sex ratios among the captive-born young were 52 males to 41 females. Males predominated in five of the litters; in the sixth there were five males and nine females.

Tail length/total length ratios for males of all sizes are 0.26–0.28 (0.274); for females, 0.23–0.26 (0.246).

Ecology and Natural History

Although the Río Aguanaval originates in the highlands of Zacatecas, it flows, along much of its course, through mesquite-grassland and terminates in the desert (Leopold, MS). Summer temperatures are cool at night and moderately high by day, and most of the rainfall occurs during the period from June to October, inclusive. Data assembled at Río Grande on the river indicate that maximum temperatures reach 30° C. during every month of the year, and the highest ever recorded was 40° C. in June. The monthly mean maxima vary from 22.6° C. in December to 33.6° C. in June. The monthly mean minima are only 14.2° C. and 14.0° C. for July and August, and the absolute minima recorded for the same two months were 9° C. and 8° C., respectively. Daily changes in temperature are rapid, and sudden drops occur during afternoon thunderstorms. Pre-

cipitation at Río Grande averages 443 mm. annually. (Climatological statistics are from Contreras Arias, 1942.)

All our specimens of *alta*, with the exception of the type, were collected in or near two impoundments along the river where water is present even when the rest of the stream may be dry, or virtually so. The upper of the two dams, situated on the Río Florido about a mile downstream from the village of Río Florido, had a concrete apron and sluiceways for controlling floods and irrigation and, when full, maintained a long, narrow lagoon perhaps a half mile in length that occupied the bed of the river and supported riparian groves of willows and cottonwoods (pl. 15, fig. 2). Water snakes were found in vegetation in shallows near the banks and in the stream below the dam. One, taken at the latter place and the only specimen of *alta* collected at night, was obtained shortly after dark below a raceway as it worked its way upstream, just out of a swift current, through sparse vegetation at the edge of the water.

The second dam, situated on the Río Medina a mile or two downstream from the town of Rancho Grande, was smaller, less substantially constructed, and impounded only a few acres of water. The sluiceways were of concrete, but the dam breast was of earth covered with large rocks laced together by willows and other growth that probably would be insufficient to hold the mass in place during periods of severe flood. Erosion was normally controlled by leaving the sluice gates open throughout the summer rainy season.

During the morning of August 21, 1960, I caught seven large females of *alta* among the rocks on the dam breast. All were lying out in the open shortly after 8:00 A.M. and obviously were basking after the preceding cool and stormy night. Data recorded at 9:00 A.M. were: air temperature, 21.5° C.; water temperature, 20.0° C.; pH, 6.5 (of water in the stream); altitude, about 6500 feet (1981 meters).

When we revisited this locality on July 22 and 23, 1962, the water was much lower, and a juvenile of *alta* was found crawling along the bottom of one of the nearly dry sluiceways. Two adult males were caught, and a very strongly patterned, half-grown individual was seen the same day along one of the irrigation canals below the dam. During the third visit, on July 3, 1965, at the beginning of the rainy season, the water was very low, and no *Natrix* was seen. That the rocky dam breast is frequently used by the water snakes, at least during the summer months, is attested by the finding of numbers of shed skins among the stones and vegetation during all three of our visits.

The type specimen was taken in the river at an altitude of 6700 feet (2042 meters) near the village of Río Florido (pl. 15, fig. 1) about mid-morning on a clear, sunny day as it swam between me and the nearby river bank as I stood knee-deep in rapidly flowing water. In its efforts to escape, the snake crawled ashore where I could catch it. Another individual of medium size and a very large female were seen swimming a few minutes later. These snakes were on the move about the same time of day that considerable activity was noted in a colony of *Thamnophis melanogaster canescens* (Conant, 1963c, p. 479). Specimens of *Thamnophis eques megalops* were also collected at both localities where *alta* was found, and that species of garter snake was also abundant downstream near the Presa Cazadero where, however, no specimens of *Natrix* were encountered.

At the high elevations of central Zacatecas little nocturnal activity was observed among reptiles of any kind, although amphibians, especially *Rana pipiens*, were frequently seen at night. Only a single *alta*, as noted, and one garter snake were found prowling after dark. During the rainy season opportunities for basking must be few and confined to the early half of the morning or occasionally the late afternoon. The nights were chilly, with temperatures often dropping to 15° C. or even 10° C. During a typical day the temperature rose to 30° C. or higher, and all semiaquatic reptiles retreated to shade or the water. On most days during our visits to the area, there were afternoon thundershowers, the great heat of the day dissipated rapidly before a cooling breeze, and any reptiles that may have been abroad, including lizards, quickly disappeared from sight.

Six of the seven large females of *alta* from the Río Medina near Rancho Grande gave

birth to litters of young; data for these are included in table 19. One of the same six females, after being caged alone in captivity, bore a single live young on September 13, 1962, and thus furnished evidence for the first case of amphigonia retardata reported among North American *Natrix* (Conant, 1965b, p. 142).

THE MEXICAN SUBSPECIES OF *NATRIX RHOMBIFERA*

There are three subspecies of *Natrix rhombifera* in Mexico, two of them endemic, and all are confined to drainage systems (*cuencas*) of the east coast or their associated marshlands and deltas. Differences in coloration and intensity of pattern are of importance in separating the three forms as are two scale characteristics; subcaudal counts are low in the subspecies *rhombifera*, and *werleri* is unique in usually having two or three preoculars instead of one (chart 3).

Distribution

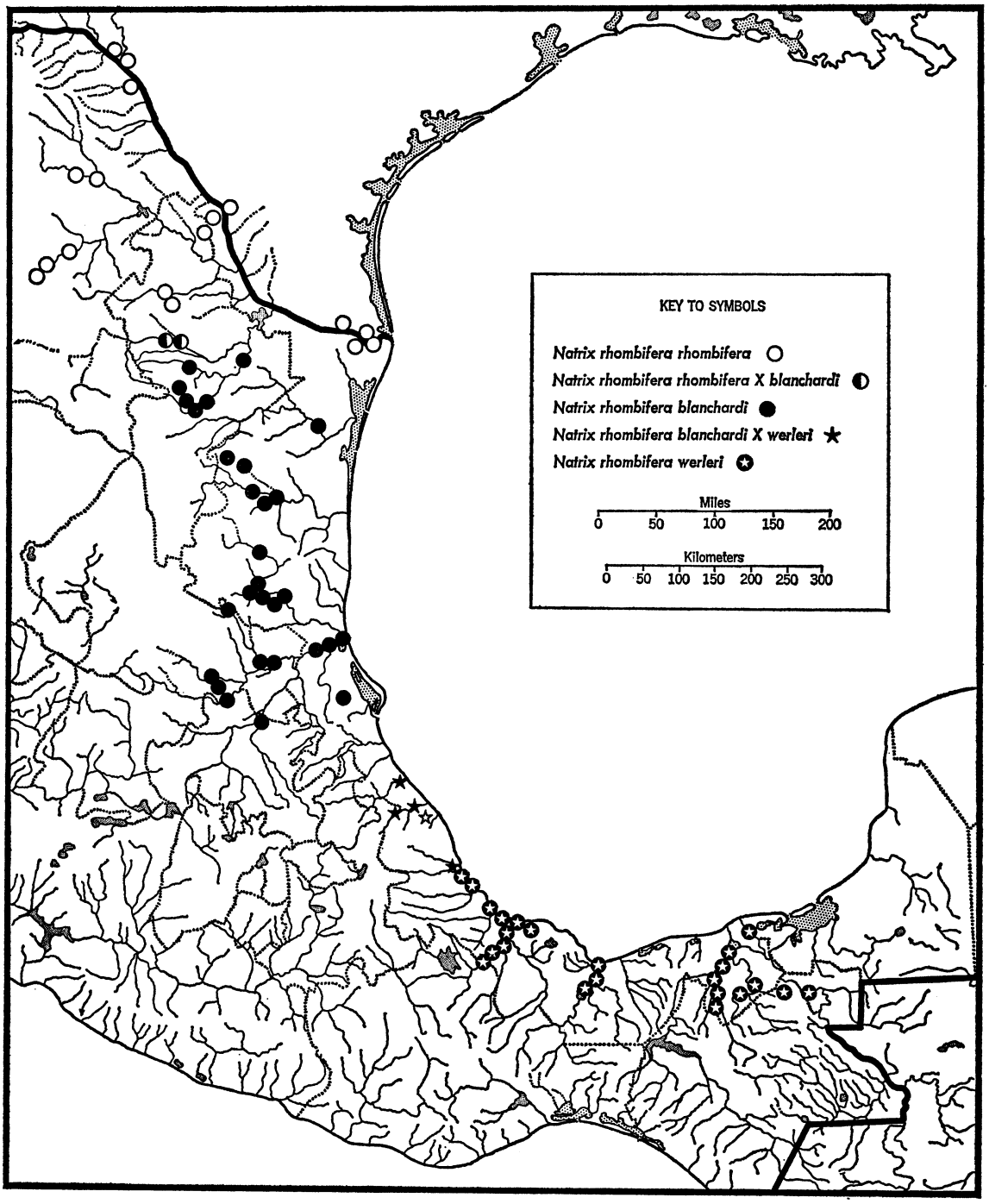
The species as a whole ranges from Kansas, Indiana, and Alabama to central Texas (Conant, 1958, map 92) and southward through Mexico to Tabasco and probably well into Campeche, Chiapas, and Oaxaca.

The nominate race, which occurs in Coahuila, Nuevo León, and Tamaulipas, has a distribution in Mexico (maps 2 and 3) that approximates the range of *N. e. transversa* (map 1). The subspecies *blanchardi* occupies the great plexus of rivers discharging through the Río Tamesí and the Río Pánuco that have contact through the delta-like swamps and channels of the Laguna del Chairel region directly west of Tampico, and it also occurs in several other drainage systems, from the Río San Fernando and the headwaters of the Río San Juan in the north to at least the Estero Cucharas in the south. The southernmost race, *werleri*, ranges from central Veracruz southward along the coast and through the great swamplands of Tabasco.

CHART 3

Diagnostic Characteristics of the Three Subspecies of *Natrix rhombifera*

Characteristics	*rhombifera*	*blanchardi*	*werleri*
Dark dorsal pattern	In strong contrast with ground color; black, dark gray, or very dark brown	Weak or vague, virtually absent from some; dull brown or olive	Moderate to strong; black or dark brown
Extent of pale pigment on scales included in dark dorsal pattern	Averaging one-half or less of each scale	More than half of each scale in juveniles; considerably more in adults	Usually one-half or more of each scale in lateral pattern elements; middorsal elements chiefly solid black or brown
Diagonal lines connecting middorsal and lateral markings	Present or at least strongly indicated	Obsolete or only weakly indicated	Usually present, but often incomplete or irregular
Ventral markings	Dark half moons in strong contrast with ground color throughout most of length of body and tail	Weak; represented by dark, smudgy areas, at least in adults; underside of tail may show pattern in juveniles	Frequently moderate to strong; usually at least some indication of half moons; underside of tail strongly patterned
Number of preoculars	1	1	2 or 3
Number of subcaudals			
Males	68–77, mean 72.2	76–88, mean 81.3	78–86, mean 82.2
Females	56–66, mean 60.0	63–73, mean 68.6	64–73, mean 68.0



MAP 2. Stream map showing locality records for the subspecies of *Natrix rhombifera* in Mexico and Rio Grande drainage in the United States. The single hollow star represents a literature record for Misantla, Veracruz.

The collective vertical range of the three taxa in Mexico is from virtually sea level at Tampico (and doubtless at many other localities) to approximately 745 meters (2444 feet) in the Cuatro Ciénegas *bolsón* in Coahuila.

In the arid north of Mexico the populations are restricted to streams and the vicinity of springs and to the infrequent swamps and other moist habitats that are sufficiently large to support such food animals as frogs and fishes. Most of the northern populations are isolated from one another as a result of the fragmentation of what had been a much wider distribution of the species during one or more of the pluvial periods of the past. Farther south, where water is abundant, the range is much more nearly continuous, and snakes of this complex are widespread.

Size and Proportions

The snakes of this complex are large and stout-bodied, and the females attain greater lengths and considerably greater girths than males. Among the Mexican populations many females exceed 1300 mm. in total length; the largest entire specimen (*werleri*) measures 1458 mm. (head-body length, 1141 mm.), and another (also *werleri*) with a portion of the tail missing measures 1470 mm. (head-body, 1162 mm.). The largest specimen of *rhombifera* measures 1376 mm., and the largest of *blanchardi*, 1358 mm. Only a few males exceed 1000 mm. in total length. The largest male with a complete tail measures 1067 mm. (head-body, 806 mm.), and another with part of the tail missing measures 1059 mm. (head-body, 862 mm.). These two snakes and the next two largest males are from populations of the subspecies *rhombifera*; only one male each of *blanchardi* and *werleri* exceeds 1000 mm. in total length. The greater girth of females, as among members of the *N. erythrogaster* complex, is associated with a higher average number of scale rows and the retention of higher numbers throughout a greater length of the body.

The head is large, broad, and distinct from the neck. In young snakes the eye is relatively large, but it becomes proportionally smaller with age. Among juveniles measuring less than 300 mm. in total length, the eye is almost invariably greater than its distance from the nostril. Among adults (snakes measuring more than 700 mm.) the situation is reversed, and the eye is smaller than its distance from the nostril, and considerably smaller in very large adults. Among snakes of medium size (total lengths of 300 to 700 mm.) the two measurements are about equal.

The body is rounded in cross section; the tail is moderately long and attains a greater proportionate length in males than it does in females.

Juveniles are proportionally more slender than adults, but otherwise are similar. Newborn young vary from 245 mm. to 295 mm. in total length (table 20).

Chin Papillae

Large adult males bear prominent papillae on the chin, a characteristic that is unique among North American natricine snakes. These first appear when males attain a total length of approximately 700 mm., although there is much individual variation. For example, in a male measuring only 655 mm. in total length faint indications of papillae are present, but these projections are equally as faint in another measuring 756 mm. In general, however, the papillae increase in size, and apparently in number, as the snake grows, and virtually all males in excess of 800 mm. have them conspicuously in evidence. Their development is probably associated with the attainment of sexual maturity as Blanchard (1931, p. 102) suggested.

Papillae are especially prominent in a male (C.M. No. 9514, *blanchardi*) from the general area west of Tampico. Their number and extent in this snake, which measures 860 mm. in total length but lacks the tip of the tail (head-body length, 661 mm.), may be summarized as follows: Papillae present on the mental, the first six infralabials on both sides of the mouth, and all four of the chin shields, but strongly enlarged only on the scales enumerated below and for which the number of large to medium papillae are indicated in parentheses: mental (one), left first infralabial (four), right first infralabial (six), left anterior chin shield (24), and right anterior chin shield (25). Smaller papillae are also present on all these scales and on the second to sixth infralabials and the anterior

ends of the posterior chin shields. In general the same scales are involved in all adult males, but the largest, most prominent papillae are clustered on the mental, first infralabials, and the anterior chin shields.

Blanchard (1931, pp. 96, 100–101) illustrated papillae in *Natrix rhombifera* and ascribed a sexual (hedonic) function to them. Regardless of their use, they are an excellent ancillary character for identification. Only adult males of the *rhombifera* complex bear such protuberances. Not all large males, however, have them. In one from 9 miles east-northeast of Tlacotalpán, Veracruz (C.M. No. 39469, *werleri*), there are no enlarged papillae on any of the chin scales; this snake measures 944 mm. in total length (head-body, 692 mm.), and both hemipenes are everted in the preserved animal. It is the only large male among the many specimens examined that lacks papillae. A few very small papillae are present on the chin of an adult female (L.S.U.M.Z. No. 10816, *blanchardi*) from near Tamuín, San Luis Potosí (total length, 871 mm.; head-body, 668 mm.). Similar protuberances may have been overlooked in other females; normally this characteristic was checked only among male specimens.

Scutellation

The dorsal scales are strongly keeled, with the exception of those of the lowermost row, which are weakly keeled. The keels in the anal region are knobbed in males, and strongly so in large ones. Most of the dorsal scales bear paired apical pits. The maximum number of scale rows is most frequently 27 among females and about evenly divided between 25 and 27 among males. The minimum number of rows is normally 21, but in a few snakes, chiefly males, there is a reduction to 19 or fewer. The anal plate is divided in all specimens examined.

The number of subcaudal scutes and the number of preoculars are both of taxonomic significance. Other variations in scutellation among the races of *rhombifera* are discussed on page 55.

Frontal/Parietal Ratios

The means and observed ranges of the ratios resulting from dividing the length of the frontal plate by the length of the parietal are shown in table 16 for Mexican races of the *rhombifera* complex. Similar ratios for populations inhabiting the United States are being assembled for later publication.

The length of the frontal was measured from the posterior end of the common suture between the prefrontals to the posterior point of the frontal. The length of the parietal was measured from the point where the frontal, parietal, and supraocular join to the posterior end of the parietal. Measurements were made with vernier calipers, and the right parietal was used in every case unless it was damaged.

In every snake examined the length of the parietal is greater than the length of the frontal, although in a few snakes in several populations the two scales are nearly equal in length. The means (table 16) indicate that the parietal tends to be shortest in the south (in *werleri*) and longest in the north (in

TABLE 16

Comparison of Frontal/Parietal Ratios Among the Subspecies of *Natrix rhombifera* in Mexico

Subspecies	Males	Females
rhombifera		
Mean	0.80	0.77
O.R.	0.61–0.96	0.64–0.88
blanchardi		
Mean	0.83	0.83
O.R.	0.69–0.98	0.66–0.92
werleri		
Mean	0.89	0.88
O.R.	0.79–0.98	0.73–0.98

rhombifera), with an intermediate condition in *blanchardi*.

Several authors have suggested that *Natrix taxispilota* of the southeastern United States is conspecific with *rhombifera* (Cagle, 1952, p. 20; Blair, 1958, p. 459; and Milstead, 1960, p. 82), but they apparently have failed to consider the sharp distinctions that are manifest between *rhombifera* and *taxispilota* in such features as chin papillae, parietal scutes, and pattern. As stated on page 32, *rhombifera* is the only North American water snake bearing chin papillae in the male. In *taxispilota* the parietals are shortened and serrated posteriorly, a condition that does not occur in *rhombifera*. These and other differences now under study indicate that *rhombifera* and *taxispilota* have differentiated to the specific level.

Coloration and Pattern

The basic pattern in all races of *rhombifera* consists of a series of dark, middorsal, subsquarish spots connected by diagonal lines with dark vertical bars on the sides of the body. The coloration, especially the degree with which the markings contrast with the paler ground color, varies among the several subspecies.

The dark middorsal markings are one and one-half to two scales long (in the longitudinal axis) and four or five scales wide. The dark lateral vertical bars are about two scales wide and extend from the eighth or ninth (seventh posteriorly) row of scales downward to the lateral tips of the ventrals. The diagonal dark lines connecting the lateral bars with the middorsal markings vary in width from almost a full scale to only a narrow line along the edges of the scales, and they may or may not be interrupted by pale pigment. The diagonal lines are faint or absent in *blanchardi*, but even among many individuals of the other races they are relatively inconspicuous. In general, they are the weakest and most poorly defined of all the dorsal markings.

There is a tendency, rather marked in some specimens, for pale (usually yellowish) pigment to be present on the scales immediately adjacent to the dark markings, and it is most conspicuous on the sides of the body. In many specimens there are relatively inconspicuous "shadow" spots between the dark vertical bars, the "shadow" spots being flanked at each side by the yellowish pigment described above.

The pattern is distinct in juveniles of all races, but it becomes obscure or may be virtually absent in adults of *blanchardi*, and rarely in individuals of the other subspecies. The number of middorsal markings was recorded for each countable specimen from the dark blotch (in many cases split into a right and a left half) at the rear of the head to the last complete marking anterior to a point directly above the anus, inclusive. Counts could almost never be made with accuracy on the tail because of the irregular fusion of adjacent ones, and the markings were, in almost every case, not discrete toward the end of the tail.

The frequent splitting of the most anterior dark middorsal marking is associated with the presence of a pale middorsal stripe on the neck in many individual snakes. It may split two or more dorsal markings into halves, and these may fuse with the adjacent markings to form a dark border at each side of the pale stripe. In extreme cases the stripe may be long as, for example, in a specimen of *blanchardi* from Llera, Tamaulipas (T.U. No. 17768). In this snake there is a pale, dull yellowish middorsal stripe varying from two to three scales in width. It is flanked at each side by a pale gray stripe that is confluent with the first two, albeit longitudinally attenuated, dorsal markings. The length of the light stripe is 16 scales counted along the middorsal line. Pale neck stripes of varying lengths may or may not be present in individuals of all three races of *rhombifera*, but there is no apparent geographical or subspecific trend associated with the presence or absence of the stripe.

Hemipenis

The everted hemipenis may be described as follows: Shaft subcylindrical, nude at its base and in the vicinity of the two groups of accessory spines; ornamented proximally by spines and spinules, but these are replaced abruptly on approximately the distal half of the organ by masses of very small papillose structures terminating in minute spines. Apex bilobed and nude throughout the

forked area. Sulcus simple and terminating at the junction of the two lobes. A large basal hook (free edge 2.5 mm. to 3 mm. long in snakes measuring 750 mm. to 1000 mm. in total length), followed distally by another hook almost as large that is flanked toward the sulcus by a cluster of enlarged spines. A pair of small accessory hooks, on the opposite side of the sulcus, one distal to the other, then a nude area (in the direction away from the sulcus), and then another pair of small hooks, again one distal to the other, and followed by another nude area.

In situ the hemipenis extends caudally to the sixth to eighth subcaudal, and the M. retractor penis magnus originates on the caudal vertebrae at the level of the twenty-sixth to the thirtieth subcaudal.

Geographical Variation

Variations in scutellation are shown in tables 1–3, 5, 7–10, but the more conspicuous ones are discussed herewith.

Subcaudal counts are low in the north (subspecies *rhombifera*), but they increase abruptly in *blanchardi*, even among populations of the latter from the Río San Fernando and the headwaters of the Río San Juan, the northernmost streams occupied by *blanchardi*. The subcaudals show virtually no further change in snakes taken toward the south, and, if proper allowance is made for sex, the observed ranges and means for *werleri* are very similar to those of *blanchardi*. (See table 2.)

One preocular is normal in *rhombifera* and *blanchardi*, but two, or occasionally three, preoculars are usually present in *werleri*.

Several other counts tend to be higher in *werleri* than in *blanchardi* or the Mexican populations of *rhombifera*. These include slightly to considerably higher average counts for labials, postoculars, temporals, and number of scale rows in comparison with the other subspecies. On the contrary, the means for ventrals are slightly lower for both sexes. In *werleri* the orbit is completely cut off from the supralabials in 20.1 per cent of the counts, in comparison with 12.5 per cent in *blanchardi*; in Mexican specimens of *rhombifera* the fourth supralabial enters the eye in every case.

There is considerable geographical variation in coloration and pattern in the *rhombifera* complex. Dark pigmentation, on both the dorsum and venter, is most pronounced in the far northeast of Mexico and in the south in Tabasco and the adjacent areas. The dark pattern elements are prominent in *rhombifera*, they are suppressed among the intergrading populations from along the Río Salinas, in Nuevo León, and they all but vanish among many adults of *blanchardi*. Dark pigment appears again well north of the city of Veracruz, at least on the dorsal surfaces. The dorsal patterns are conspicuous among snakes from the delta of the Río Papaloapan and associated streams, but dark pigment ventrally is confined chiefly to the posterior part of the belly and beneath the tail. In snakes from Tabasco dark pigment is abundantly present both on the dorsum, where the markings are wider and blacker than they are among snakes from farther west and north, and on the venter where they take the form of large black or very dark half moons. Variation in pattern among snakes of the *werleri* complex is discussed on page 76.

Natrix rhombifera rhombifera (Hallowell)

Diamond-backed Water Snake

Plate 1, figure 2, plate 6, figures 1–4, plate 7, figure 7

Tropidonotus rhombifer Hallowell, 1852, p. 177.

Natrix rhombifera rhombifera: Clay, 1938, p. 251.

Type and Type Locality

A.N.S.P. No. 5047, holotype, a young adult male collected by Samuel Washington Woodhouse and stated to be from the "Arkansas river and its tributaries, near the northern boundary of the Creek Nation" (Hallowell, 1852, p. 177).

This snake, although still in relatively good condition, has the appearance of being shrunken and desiccated, and it may have been among the many specimens the late E. R. Dunn found in bottles from which the alcohol had evaporated when he curated the collection of the Academy of Natural Sciences of Philadelphia during the 1930's. The maximum number of scale rows and the number of subcaudals check exactly with Hallowell's description, as does the number

of ventrals if he included, as he probably did, a scale at the anterior end of the series which would be omitted under the Dowling (1951b) system. The snake now measures 734 mm. in total length and 177 mm. in tail length in contrast with Hallowell's "2 ft. 8 inches" (813 mm.) and "6½ inches" (165 mm.), respectively. There obviously has been considerable shrinking of the body.

My scale counts are: scale rows 23–25–23–21–19–18; ventrals 141; subcaudals 70; supralabials eight, the fourth entering the eye on the left side of the head and the fourth and fifth on the right; infralabials 10 on the left side and 11 on the right; one preocular and three postoculars; one anterior temporal and two posterior temporals. There are 34 dark cross bands along the midline of the body from immediately behind the head to a point directly above the anus.

Cochran (1961, p. 223) listed U.S.N.M. No. 7253 as a "cotype" of Hallowell's *Tropidonotus rhombifer*. This snake, an adult female in poor condition, has only 135 ventrals, and the tail is incomplete and includes only 50 subcaudals. As is the case with the "cotype" of *Tropidonotus transversus* (p. 27), U.S.N.M. No. 7253 cannot stand as a "cotype" (=syntype) of *Tropidonotus rhombifer*, for Hallowell described only a single specimen, and it is identifiable with A.N.S.P. No. 5047.

The type locality is identical with that of *Natrix erythrogaster transversa* (see discussion on p. 27), and, in terms of present-day localities, should be stated as "Arkansas River between Keystone and Tulsa, Tulsa County, Oklahoma."

Range

In Mexico, *rhombifera* occurs in the states of Coahuila, Nuevo León, and Tamaulipas, or, in terms of river basins, in the Río Bravo del Norte (Rio Grande) and its two principal lower tributaries, the Río Salado and the Río San Juan (maps 2 and 3). It is known from many localities in the Salado system and ascends far upstream to the vicinities of Múzquiz and Nadadores. There are no definite records for pure demes of *rhombifera* from the San Juan system, but flourishing intergrading populations between *rhombifera* and *blanchardi* occur both at Ciénega de Flores and Salinas Victoria in its Salinas-Pesquería affluent. The total absence of material from the lower portions of the San Juan and its more northern tributaries is regrettable, for even small samples might help to shed light on what appears to be an anomalous distribution. The southernmost tributaries of the San Juan, including the Río de Monterrey and several streams that flow into it, are inhabited by *blanchardi*, a circumstance that suggests the possibility of stream capture from the San Lorenzo-Conchos-San Fernando system (see p. 65).

The populations of *rhombifera* in the great springs of the otherwise arid Cuatro Ciénegas basin were isolated prior to the establishment of the canal system that now connects many of them with the Río Nadadores (see p. 34).

The vertical distribution in Mexico is probably from virtually sea level in the lower Rio Grande to approximately 745 meters (2444 feet) at the Pozos de la Becerra in the Cuatro Ciénegas basin.

The locality records and museum numbers for 68 Mexican specimens studied in detail are:

Coahuila: Celemánia (U.M.M.Z. No. 124642); Rancho de las Rusias, Múzquiz (F.M.N.H. Nos. 47051–47065); Río Sabinas at San Juan de Sabinas (A.M.N.H. Nos. 89115–89127); Río Salado de los Nadadores at El Cariño, 2.5 miles north-northeast of Sacramento (A.M.N.H. Nos. 85224–85229, 88790, 88791; K.U. No. 80285; U.M.M.Z. Nos. 122438, 124643); Río San Diego, 2 miles west of Jiménez (K.U. Nos. 39962, 39964, 39997).

Nuevo León: Twenty-one and a half miles south and 12 miles west of Nuevo Laredo (T.C.W.C. No. 17186); Ojo de Agua, 4 miles west of Sabinas Hidalgo (A.M.N.H. Nos. 89063–89072; F.M.N.H. Nos. 34414–34417, 34423–34429); 8 miles south of Sabinas Hidalgo (A.M.N.H. No. 89057).

Tamaulipas: Nine and three-tenths miles west of Matamoros (E.A.L. No. 875); 9 miles southwest of Nuevo Laredo (B.C.B. No. 11650).

Also see page 60 for records from the Cuatro Ciénegas *bolsón* in Coahuila.

On the basis of recently acquired information it is evident that *rhombifera* occurs in Rio Grande drainage in "The Valley" of

extreme southern Texas, and the distribution map published in 1958 (Conant, map 92) requires emendation. The diamond-backed water snake is now known from several localities in Cameron County, for example, and probably ranges naturally through the general region, although many habitats have been altered by man. For example, Henry H. Hildebrand (personal communication) states that "the short coastal streams of South Texas are now too polluted by oilfield brine to support water snakes."

The gene pools of the native population in Cameron County, Texas, probably have been diluted by the introduction of numerous specimens of *rhombifera* from other, possibly distant, localities in conjunction with the operation of the now defunct, but once flourishing, animal business conducted by the late W. A. ("Snake") King at Brownsville. Some of these escaped, and others were liberated. Information received by Pauline James (personal communication) indicates that, "Boys who came to South Texas from another part of the state on their Easter holiday in 1937 hoped to pay for their trip by bringing along a few sacks of snakes. When King refused to buy their *rhombifera* they turned them loose in a *resaca* near Bayview." James has seen specimens from *resacas* east of San Benito, from west of Olmito, northeast of Brownsville, and in the Mercedes Reservoir and settling basin. Ted Beimler (personal communication) states that *rhombifera* is common at Brownsville and Olmito. The species probably occurs naturally in most or all of these localities. Data for preserved specimens from "The Valley" and other localities in the United States from the vicinity of the Rio Grande are:

TEXAS: *Cameron County*: Brownsville (A.M.N.H. No. 93097; C.U. No. 1162; K.U. Nos. 13658, 13692); 3.3 miles east of Brownsville (L.D.W. No. 3386); 6 miles east and 1.5 miles south of Brownsville (L.D.W. No. 3393); 4 and 5 miles north of Brownsville (A.M.N.H. Nos. 99040, 102178); Rabb's Palm Grove, Southmost (A.M.N.H. No. 93098); State Fish Hatchery, 3 miles south of Olmito (U.U. No. 4001). *Hidalgo County*: Mercedes (A.M.N.H. No. 102179). *Val Verde County*: Del Rio (S.R.S.C. Nos. 342, 356, 357); Devils River (C.U. No. 8192); Devils River Crossing (C.U. No. 755); Evan's Creek, 15.5 miles northwest of Del Rio (U.U. Nos. 3992–4000). *Webb County*: Chacon Creek, Laredo (M.C.Z. No. 45552). (Also see below for records from Pecos River and Calamity Creek localities.)

Dorothea Treviño Robinson, who reported on ichthyological collections made in the lower Rio Grande (1959), saw (personal communication) water snakes that she presumed were *rhombifera* in Kinney, Val Verde, Webb, and Zapata counties, Texas. No specimens were collected, but they were abundant in stock tanks, creeks, and backwaters near the Rio Grande.

Only one specimen (E.A.L. No. 875 from 9.3 miles west of Matamoros) is known from the Mexican side of "The Valley." No data are available on whether the species is widespread through the irrigated district west and southwest of Matamoros, Tamaulipas, or in natural habitats of the general area, but it probably is.

Upstream along the Rio Grande there are no recent records for *rhombifera* from beyond the vicinity of the Devils River in Val Verde County, Texas, or beyond the vicinity of Jiménez (near Villa Acuña), Coahuila. There are, however, two old records from upstream localities: (1) Pecos, Texas (based on two specimens in the collection of the Academy of Natural Sciences of Philadelphia, Nos. 12097 and 12107, credited to Arthur Erwin Brown and collected in 1900); and (2) Calamity Creek, Brewster County, Texas (Strecker, 1909, p. 14). Such information as I have been able to assemble on the herpetological activities of Brown, who served as executive head of the Philadelphia Zoological Garden from 1876 until his death in 1910, indicate that he did little if any field work, and all his material from Texas was collected by persons with whom he corresponded (Conant, 1957). It is possible, of course, that the two specimens of *rhombifera* came from the "Pecos River" or from "Pecos County" rather than from the town of Pecos, which is in Reeves County, but, regardless of their point of origin, they would represent the only records of specimens extant from Pecos River drainage. (For comments on the Calamity Creek locality, see p. 30.) Whether these two localities, Pecos and Calamity

Creek, were formerly inhabited by isolated populations of this water snake or whether it occurs elsewhere in upstream portions of the Rio Grande watershed is unknown. The increasing desiccation of the region during recent years (Milstead, 1960) may have caused the extirpation of the species in both places and perhaps elsewhere. How far *rhombifera* ascends the main stream of the Rio Grande is also unknown. The fact that the river is an international boundary has been a deterrent to collecting (see p. 28).

Identification

A strong, netlike pattern of black or dark brown markings on a brown or olive-brown ground color (pl. 6, figs. 1 and 3) is characteristic of the subspecies *rhombifera*. The belly and under side of the tail are strongly patterned with black, dark gray, or dark brown pigment that, in part, takes the form of half moons concentrated toward the sides of the ventrals. In juveniles the dark markings contrast strongly with the pale ground color, especially on the venter. Large males have numerous papillae on the chin.

Individuals that are approaching ecdysis may be confused with specimens of *N. e. transversa* (see p. 32). The chief characters for separating members of the species *rhombifera* from members of the *N. erythrogaster* complex are indicated in chart 1.

The strong pattern of *rhombifera*, in which the dark markings, both dorsal and ventral, contrast with the paler ground colors, distinguishes this taxon from *blanchardi*, in which the markings are suppressed or virtually absent. The characteristics of the three races of *N. rhombifera* are shown in chart 3.

Scutellation

Scale counts in *rhombifera* (excluding material from the Cuatro Ciénegas *bolsón*) follow: Ventrals in males, 141 to 152, mean 146.0; in females, 137 to 146, mean 141.8. Anal plate divided in all specimens. Subcaudals in males 68 to 77, mean 72.2; in females, 56 to 66, mean 60.0.

The most frequent dorsal scale-row formula is 25–27–25–23–21, but there are many variations. A maximum of 27 scale rows is much more common among females (in 87% of all of that sex) than among males (37%). A maximum of 25 occurs among 13 per cent of the females and 45 per cent of the males. A few males have maxima of 24 or 26 rows. The minimum number of scale rows is 21 among 77 per cent of the females and 55 per cent of the males. Among the 68 specimens examined nearly 18 per cent have 19 or fewer rows, but most of the low counts occur in males.

Dorsal-scale reductions among four males with maxima of 25 rows are:

25 5+6 or 6+7 (74–88)—*23* 4+5 or 5+6 (99–110)—*21* (146–148)

Scale reductions among four females with maxima of 27 rows are:

27 5+6 or 4+5 (65–85)—*25* 5+6 or 6+7 (84–110)—*23* 4+5 (109–129)—*21* (139–144)

In two females with counts of 25 in the neck region the increase to 27 rows occurs through the addition of a sixth or seventh row that appears variously from above ventrals 28 to 33, inclusive.

Supralabials eight, except in one female in which the last two labials on each side of the head are fused with each other, to give a count of seven; infralabials 11, but 10 in some counts, and rarely 12. Almost invariably a single preocular, rarely two; postoculars usually three, but two in some counts, and rarely four. Invariably a single anterior temporal; temporals in second row two, three in some counts, and one in a single count. The fourth supralabial enters the orbit in every case.

Irregularities in Scutellation

The temporals are highly irregular in the population sample (nine males and three females ranging in total length from 264 mm. to 1073+ mm. and including only two juveniles) from the Río de los Nadadores at El Cariño, Coahuila. In many cases the anterior temporal is split in two vertically to form two scales of which the anterior is the smaller. In other cases the anterior temporal is fused with the upper posterior temporal or the two upper secondary temporals are fused with each other to form a single large scale. Various combinations of these aberrations occur in individual snakes, and the temporal counts for them, which are included in table 10, were made objectively. In an adult female

(length, 811 mm.) from the Rancho de las Rusias near Múzquiz, Coahuila, the parietal extends downward on each side of the head to meet the sixth upper labial and cuts the anterior temporal off from the postoculars. The same abnormality occurs on one side of the head in each of two other snakes from the same locality.

Coloration and Pattern

The dorsal view of the head, a lateral view at midbody, and a ventral view at midbody of an adult female are illustrated in color (pl. 1, fig. 2). The colors shown are more or less typical of this taxon in Mexico, but there is individual variation in the intensity of the dark markings on both the dorsum and venter and in the tone of the dorsal ground color, which is paler in some individuals.

Among adults, the dorsal ground color varies from brown to olive (Saccardo's Umber to Light Brownish Olive or Yellowish Olive) in the middorsal area; on the sides of the body the coloration is a paler, more yellowish brown or olive (Isabella Color or Tawny-Olive). The dark, netlike markings, which are composed of cross bands in the middorsal region and are connected with similar vertical lateral markings by diagonal dark bars, are dark brown to black, but they may be slightly paler on the sides of the body in some individuals. The venter is yellow, and the ventral markings are dark brown to black.

The general coloration of a large adult male from the Ojo de Agua, 4 miles west of Sabinas Hidalgo, Nuevo León (pl. 6, figs. 3 and 4) may be summarized as follows: Dorsal ground color brown (Saccardo's Umber) middorsally, but changing to yellowish brown (Tawny-Olive) on the sides of the body. Dorsal markings black, the lighter areas within them (chiefly on the posterior halves of the scales) the same as the ground color. Top of head Light Brownish Olive marked vaguely with slightly darker pigment (Brownish Olive). Chin and throat Mustard Yellow; belly slightly duller (Naples Yellow); under side of tail Warm Buff. Ventral markings very dark gray. Eye: Pupil black, very narrowly rimmed by yellow; iris reddish (Kaiser Brown). Tongue: Black, with a slight amount of pink at its extreme base.

In some adults there is a slightly orange tinge directly adjacent to the dark dorsal markings. In many the scale pits are quite dark and may appear almost black in extreme cases.

The dorsal ground color in juveniles is paler than that in adults, but the dorsal and especially the ventral markings are darker and more conspicuous; ventrally the maculations are usually black or very dark gray. The ground color of the venter is richer in coloration than that in adults; it is usually bright yellow, but in many young it is orange, particularly in the midventral area. For example, among 12 newborn siblings (table 20) the belly was fairly bright orange in four, dull orange in five, and yellow, with a light orange wash, in three. The mother of the litter, collected at San Juan de Sabinas, Coahuila, had a plain yellow venter that bore no trace of orange. (My files on *rhombifera* from Texas contain many notes on similar variations in the ventral coloration of captive born litters.)

The iris in a young snake measuring 404 mm. and collected 4 miles west of Sabinas Hidalgo, Nuevo León, was Chestnut. The tongue in the same animal was black, but the tips were dark gray.

The number of dark middorsal blotches in the Mexican populations of *rhombifera* varies from 29 to 41, mean 34.9. The dark markings on the tail, which are so irregular that they rarely could be counted with accuracy, vary from approximately 15 to 25.

Size and Sex

The 10 largest females have measurements as follows: Head-body length, 1105 mm. (total length 1376 mm.); 905 mm. (1134 mm.); 903 mm. (1140+ mm.); 899 mm. (1136 mm.); 883 mm. (1134 mm.); 815 mm. (920+ mm.); 813 mm. (1041 mm.); 795 mm. (1010 mm.); 795 mm. (987 mm.); and 774 mm. (900+ mm.). Comparable measurements for the 10 largest males are: 862 mm. (1059+ mm.); 829 mm. (1067+ mm.); 825 mm. (1073+ mm.); 806 mm. (1067 mm.); 795 mm. (1000+ mm.); 767 mm. (995 mm.); 718 mm. (950 mm.); 712 mm. (961 mm.); 711 mm. (942 mm.); and 695 mm. (920 mm.).

Among 12 young born in captivity on October 8, 1960, the total length measure-

ments varied from 245 mm. to 269 mm. (table 20). The sex ratio in this litter was nine males to three females.

Tail length/total length ratios for males of all sizes are 0.22 to 0.26, mean 0.239; for females, 0.20 to 0.22, mean 0.213. If the nine newborn males are omitted, the ratios are 0.23 to 0.26, mean 0.245 for males. The omission of the three newborn females does not alter the range or mean for females in general.

Populations from the Cuatro Ciénegas *Bolsón*

Because of the marked endemism that occurs among turtles, fishes, and snails in the Cuatro Ciénegas *bolsón* in Coahuila (see p. 34 for references), the available samples of *rhombifera* from that area were studied separately. Locality records and museum numbers for these are as follows:

Coahuila: East of Cuatro Ciénegas, La Angostura Canal? (A.S.U. Nos. 8430, 8431); east laguna of El Mojarral, 7.5 kilometers south and 5.5 kilometers west of Cuatro Ciénegas (A.S.U. Nos. 8427–8429); 3 miles east of Cuatro Ciénegas (A.S.U. No. 8432); Pozos de la Becerra, 9.8 miles south-southwest of Cuatro Ciénegas (K.U. Nos. 80286–80288). In addition I saw but was unable to catch a large specimen at night in a swampy area along a canal about a mile north of the Pozo de Escobedo; this locality is approximately 8 miles south of Cuatro Ciénegas.

Only three of these nine specimens are males, and all three have lost the end of the tail. In one of the females the head and anterior half of the body had been virtually skeletonized (by fishes?) before it was found. The scale counts (not included in the tables) from this small sample may be summarized as follows: Ventrals in males, 146 to 149, mean 147.3; in females, 140 to 145, mean 143.0. Subcaudals in females, 61 and 62. Maximum number of dorsal scale rows in males, 25 and 26; in females, 26 to 28; minimum number in males, 20; in females, 21. Supralabials eight, the fourth entering the orbit; infralabials 11 (12 on both sides in one female). A single preocular, except in two males, in each of which there are two on one side of the head; postoculars three, except in one female, in which there are two on one side.

The scales in the temporal region are irregular, but they fit a general pattern, in which the parietal is enlarged at the expense of the anterior temporal. In seven of the 16 instances the parietal extends downward to meet the sixth supralabial, thus completely separating the postoculars from the anterior temporal. In four other instances the situation is similar, except that the downward-extending parietal is separated from the sixth supralabial by a very small scale. In another case the anterior temporal is narrowed anteriorly, but it reaches the middle postocular. In the four remaining cases (on both sides of the head in each of two snakes) the anterior temporal is narrow and split vertically into two scales. Such a condition might be considered as an intermediate step in the expansion of the parietal scale, with the final step being fusion between the parietal and the anterior half of the split temporal.

Irregularities in the temporals are also pronounced among specimens taken at El Cariño at the eastern entrance to the Cuatro Ciénegas *bolsón*, and among some of the snakes from the Rancho de las Rusias near Múzquiz (see pp. 58–59).

The tail length/total length ratios for the only three among the eight snakes with complete tails (all females) are 0.20 in two and 0.21 in one.

In pattern and coloration the snakes from within the *bolsón* are similar to those from other parts of northeastern Mexico. The number of dark dorsal markings among the seven countable specimens varies from 35 to 38.

In all scale-count categories (excluding temporals), in tail length/total length ratios, and number of dorsal markings, the snakes from within the Cuatro Ciénegas *bolsón* fall within the range of variation of the subspecies *rhombifera* in other parts of Mexico, with only a single exception. A maximum of 28 dorsal scale rows occurs in one large female (A.S.U. No. 8430 from east of the town of Cuatro Ciénegas); such a high count was not noted in any other Mexican member of the entire *rhombifera* complex.

Intergradation with *blanchardi*

Forty-nine snakes of the *rhombifera* complex from the Río Salinas, a tributary of the

Río Pesquería of the San Juan drainage system, are intermediate in pattern characteristics and some features of scutellation between those exhibited by the subspecies *rhombifera* and those shown by *blanchardi*. These snakes are considered to be intergrades. Locality records for them are:

NUEVO LEÓN: Río Salinas at Ciénega de Flores (A.M.N.H. Nos. 67893, 67894, 89058–89062, 89073–89104); Río Salinas at Salinas Victoria (A.M.N.H. Nos. 89105–89114).

Snakes from both localities are similar in details of coloration and pattern, and they are lumped together in the summary below. Included are 12 males and six females ranging in length from 328 mm. to almost 1200 mm., and a litter of 31 young born to a large female from Ciénega de Flores (table 20).

In general appearance, and with allowance for differences in pattern associated with age, these intergrades, collectively, are almost exactly intermediate between population samples of *rhombifera* from Sabinas Hidalgo and those of *blanchardi* from Cadereyta, both in Nuevo León. In comparison with *rhombifera*, the dorsal markings are considerably less prominent, the diagonal lines are reduced, light pigment involves much more than half of the scales in the dark lateral bars, and the ventral markings are fewer and less prominent (pl. 6, figs. 5 and 6). Conversely, the intergrades are much more strongly marked than the snakes of the sample of *blanchardi* from Cadereyta. Differences in the intensity of the pattern are also evident among newborn young. In the litter of intergrades from Ciénega de Flores the dark dorsal markings are paler and more ground color invades them than in a litter of newborn young of *rhombifera* from San Juan de Sabinas, Coahuila. Additionally, nine of the young in the litter of intergrades have one or more of the dark middorsal markings longitudinally elongated, a pattern abnormality that occurs in some populations of *blanchardi* (see p. 68). Four of the wild-caught intergrades also have elongated dorsal markings.

In scutellation the most striking difference between *rhombifera* and *blanchardi* occurs in the subcaudal counts, which average considerably higher in *blanchardi* and exhibit little overlap (table 2). Among the intergrades, based on wild-caught specimens, and with the exclusion of the litter of young among which there are many deformed tails, the subcaudal counts are intermediate. The means for males (for *rhombifera*, intergrades, and *blanchardi*, respectively) are 72.2, 76.1, and 81.3; the means for females are 60.0, 65.6, and 68.6. The greater length of the tail in *blanchardi* is also reflected by the tail length/total length ratios. Among males the means for the ratios are 0.239, 0.258, and 0.264, respectively; the means among females are 0.213, 0.228, and 0.235.

The intergrades are also intermediate in other features of scutellation, including ventral counts and the number of scale rows.

ECOLOGY AND NATURAL HISTORY

Natrix rhombifera rhombifera is an abundant snake in many of the streams of arid northeastern Mexico, where, as in much of Texas, it is sympatric with *Natrix erythrogaster transversa*. Most of the statements about the general habitat of the latter snake, therefore, are equally applicable to *rhombifera*, including the data regarding temperatures and rainfall (p. 39). Most of the area falls within the mesquite-grassland zone of Leopold (MS), but this snake also enters the desert in the Cuatro Ciénegas *bolsón*.

Most locality records are from along rivers, where the snakes are concentrated near the deeper water holes or where water is impounded by small dams or concrete *vados* (fords) carrying roads across the streams. Habitats of this variety are frequently bordered by concentrations of willows, among the roots and lower branches of which the snakes and the animals on which they prey take shelter. During the rainy season, when the streams are flowing, the snakes doubtless move up and down the watercourses, the distances they travel from their concentration points depending, in some measure, on the available food supply. These observations are based chiefly on our experiences along shallow streams that occupy relatively broad beds. Some of the larger rivers, as they near the Rio Grande, are deeply entrenched between steep banks, in some places scores of feet below the level of the surrounding countryside. In those we have seen no water snakes, although they probably are present, at least in the few places where trees and other vegetation are sufficiently well rooted to withstand the

attrition of racing water during the rare periods after heavy rains when the narrow channels resemble flumes. Other habitats include large springs such as the Ojo de Agua, 4 miles west of Sabinas Hidalgo, Nuevo León, and the Pozos de La Becerra, in the Cuatro Ciénegas basin in Coahuila.

Although *rhombifera* occurs in streams that are intermittent at least part of the year, it probably remains active during most of the warmer months unless drought conditions are severe. It responds to rains, however, much as do terrestrial snakes. During our first visit to Salinas Victoria on the Río Pesquería in Nuevo León, on the afternoon of September 25, 1949, we saw only a single large individual of *rhombifera* in a thicket of willows over a deep pool in the otherwise nearly dry river, but none was abroad at night, although we searched for several hours. When we returned to the same locality on October 27, 1949, after one of the heaviest rains of the season, the river was flowing and considerable water was spilling over the *vado* at the village. The evening air temperatures, which ranged from 24° down to 18° C., were approximately 10° C. cooler than they had been during the earlier visit. Water snakes were much in evidence after dark. One was found on a riffle near where scores of *Rana pipiens* were calling, and a dozen individuals of *rhombifera* were seen, half of which were caught, in the willow thicket. Some were swimming at the surface of the water; others had their heads protruding from holes in the steep bank among the roots.

On another occasion a small, recently killed individual of *rhombifera* (about 450 mm. in total length) was found on the highway 8 miles south of Sabinas Hidalgo, Nuevo León, at an elevation of about 1100 feet (335 meters), during mid-morning of September 24, 1949. It was drizzling at the time, and a heavy rain had fallen during the previous night. Sparse cactus and mesquite formed the dominant vegetation on both sides of the road, and no standing water was in sight. A few large *Rana pipiens* were seen in temporary rain pools a few miles farther south, and they took refuge in culverts under the highway. Perhaps *rhombifera* is also able to survive in otherwise desiccated habitats by seeking shelter beneath culverts and bridges where hiding places are readily available and moisture lingers longest after storms. Lizards take advantage of such situations in the same general region (Conant, 1951, p. 79). Bryce C. Brown found a small specimen of *rhombifera* (total length, 484 mm.) dead on the road 9 miles southwest of Nuevo Laredo, Tamaulipas, on June 21, 1963, in a cactus-mesquite area, and another specimen (T.C.W.C. No. 17186), measuring 555 mm. in total length, was collected in the same general area. Both Sabinas Hidalgo and Nuevo Laredo are in the portion of northeastern Mexico that, with the exception of the mountains, receives the greatest amount of rainfall, although the annual average is only 600 to 800 mm. (Shreve, 1944, p. 106).

During the warmer months, when daytime temperatures exceeding 30° C. are prevalent, *rhombifera* is almost exclusively nocturnal. The only individuals caught during daylight hours under such conditions were found beneath stones or other objects at the edges of streams. Collecting was most productive within an hour or two after dark while the snakes were actively foraging. Although they also frequent a wide variety of aquatic and semiaquatic microhabitats, riffles are favorite lurking places. Several times these water snakes were found lying in rapidly moving water, with their bodies anchored among the stones, and where they would be in excellent position to seize any small fishes that, in passing across the riffle, would momentarily be at a disadvantage in the shallow water. A male from the Río Salado de los Nadadores at El Cariño, Coahuila, measuring 1 meter in length, was observed in water not more than 6 inches deep that was running rapidly through a relatively narrow channel bordered by vegetation. The snake had its tail and part of its body firmly anchored around a clump of plants, but the rest of it was hanging free downstream. It moved its head and neck fairly rapidly back and forth, sweeping through the water with its mouth held open. Another large individual of *rhombifera* bit repeatedly at the beam cast by my headlamp where it struck the swirling water, evidently mistaking it for the movement of a fish.

We have the distinct impression that large adults of *rhombifera* are bolder and more apt

to wander farther from cover than the adults of *transversa* that frequently are associated with them. Also, *rhombifera* is less often encountered along streams that are bordered by dense groves of shrubs or trees, especially near Cuatro Ciénegas, Coahuila, where *rhombifera* occurs in and near several of the great springs of the virtually treeless basin but is apparently absent from the Río Cañon north of the town. The Río Cañon, a small but permanent stream that descends rapidly through a well-wooded canyon, is inhabited by a colony of *transversa* and of *Thamnophis proximus diabolicus*. Ribbon snakes of this race have been collected many times in association with both *rhombifera* and *transversa* in northeastern Mexico.

Probably almost all kinds of fishes, frogs, and toads are accepted as food. Captives fed voraciously on leopard frogs and smelts. Data on captive litters appear in table 20.

Natrix rhombifera blanchardi Clay

TAMPICO WATER SNAKE

Plate 1, figure 3, plate 7, figures 1–6

Natrix rhombifera blanchardi CLAY, 1938, p. 251.

TYPE AND TYPE LOCALITY

C.M. No. 9512, holotype, an adult male from "Tamaulipas, Mexico, within a radius of 85 miles of Tampico in the triangle formed by the Rio Tamesi and the Rio Panuco" (Clay, 1938, p. 251).

Clay, at the time he described this taxon, was handicapped by a paucity of material, and the more detailed information now available on subspeciation and distribution among the water snakes of the *rhombifera* complex indicates that two of the specimens he designated as paratypes (U.S.N.M. No. 46533 from Tlacotalpán, Veracruz, and F.M.N.H. No. 2039 from La Antigua, Veracruz) are actually *N. r. werleri*. I have examined all nine of Clay's paratypes with the exception of E.H.T.-H.M.S. No. 5412, which cannot now be found. It is not in the collection of the Field Museum of Natural History or the University of Illinois Museum of Natural History, each of which holds a portion of the former Taylor-Smith collection. Clay (1938, p. 252) stated, however, that it was from 20 miles south of Valles, San Luis Potosí, and thus, on geographical grounds, it is unquestionably *blanchardi*.

By consulting the records of his institution, Neil D. Richmond, of the Carnegie Museum, has been able to shed some light on the vague type locality. The type series of specimens was collected during January and February, 1937, by J. Mortimer Sheppard who cruised his yacht up the Río Tamesí for "50 or 60" miles, returned to Tampico, and then apparently ascended the Río Pánuco. Precise data were never available, and the catalogue card prepared by M. Graham Netting, who was in charge of the collection at the time, gives the locality as "Vera Cruz & Tamaulipas, up to 85 mi. from Tampico . . . taken either from the Tamesi or Panuco Rivers or tributary streams."

Fortunately, ample material is now available to show that *blanchardi* occurs throughout a large part of both river systems, and there is no need to restrict the type locality to Tampico as Smith and Taylor (1950a, p. 346) suggested.

RANGE

Central Nuevo León and Tamaulipas southward to central Veracruz and northern Hidalgo (map 2). In terms of drainage systems, *blanchardi* occurs in the Río de Monterrey and its southern tributaries (Nuevo León), in the Río San Fernando (Tamaulipas), and in all major drainage systems south to and including the Río Pánuco and the Estero Cucharas. It probably also occurs in many of the short coastal streams, but these at present are largely inaccessible to collectors.

South of the *cuenca* of the Río Soto la Marina, this snake is essentially an inhabitant of the broad lowlands that center on Tampico and extend northward to the Sierra de Tamaulipas, southward to the dissected highlands southwest of the Laguna de Tamiahua, and west to the Sierra Madre Oriental. The bulk of the localities fall below the 200-meter contour, but *blanchardi* ascends some of the rivers into the uplands, at least for short distances. The known vertical distribution is from sea level to somewhat more than 500 meters (1640 feet) at several localities along the western edge of the range (map 3).

Intergradation with *rhombifera* is known to occur in the Río Salinas, an affluent of the Río Pesquería, which, in turn, is a tributary of the Río San Juan that flows into the Rio Grande.

Intergradation with *werleri* apparently occurs in the general region of the Sierra Chiconquiaco where the mountains extend eastward to the Gulf of Mexico and virtually interrupt the coastal plain (see p. 69).

The locality records and museum numbers for 176 specimens of *blanchardi* are:

"MEXICO": (B.M.N.H. Nos. 48.7.28.74–48.7.28.78, 48.7.28.83, 48.7.28.94, 48.8.16.2).

HIDALGO: Seven and nine-tenths kilometers east-southeast of San Felipe (U.M.M.Z. Nos. 126190, 126191).

NUEVO LEÓN: Cadereyta on branch of Río Pesquería (M.C.Z. Nos. 46381–46386); El Cercado (M.V.Z. No. 56976); Montemorelos (F.M.N.H. No. 1389); Río Pilón at General Terán (E.A.L. Nos. 1002.1, 1002.2, and 1239.1–1239.23; the latter are 23 nearly full-term embryos dissected from E.A.L. No. 1002.1); Río Ramos at Allende, 20 kilometers northwest of Montemorelos (T.C.W.C. No. 882).

SAN LUIS POTOSÍ: Eleven and nine-tenths miles east of Ciudad Valles (U.S.L. Nos. 6338–6344); 12.6 miles east of Ciudad Valles (L.S.U.M.Z. No. 10817); El Salto Falls, 12 miles west of Nuevo Morelos (U.M.M.Z. No. 99561); Huichihuayán (U.S.N.M. No. 110512); 2.7 miles west of Rascón (U.M.M.Z. No. 126197); 1 mile north of Tamasopo (U.M.M.Z. No. 126194); Quinta Chilla, near Tamazunchale (T.N.H.C. No. 26935); Río Moctezuma at Tamazunchale (A.M.N.H Nos. 89128–89134, 99657); Salto de Agua (B.C.B. No. 7536); Tamazunchale (F.M.N.H. No. 106529; U.I.M.N.H. No. 24564); 16 miles north-northwest of Tamazunchale (B.C.B. No. 7537); 1.5 kilometers south of Tamazunchale (A.M.N.H. No. 58211); 1 mile southwest of Tamazunchale (A.M.N.H. No. 99144); 1.3 miles east of Tamuín (L.S.U.M.Z. No. 10816).

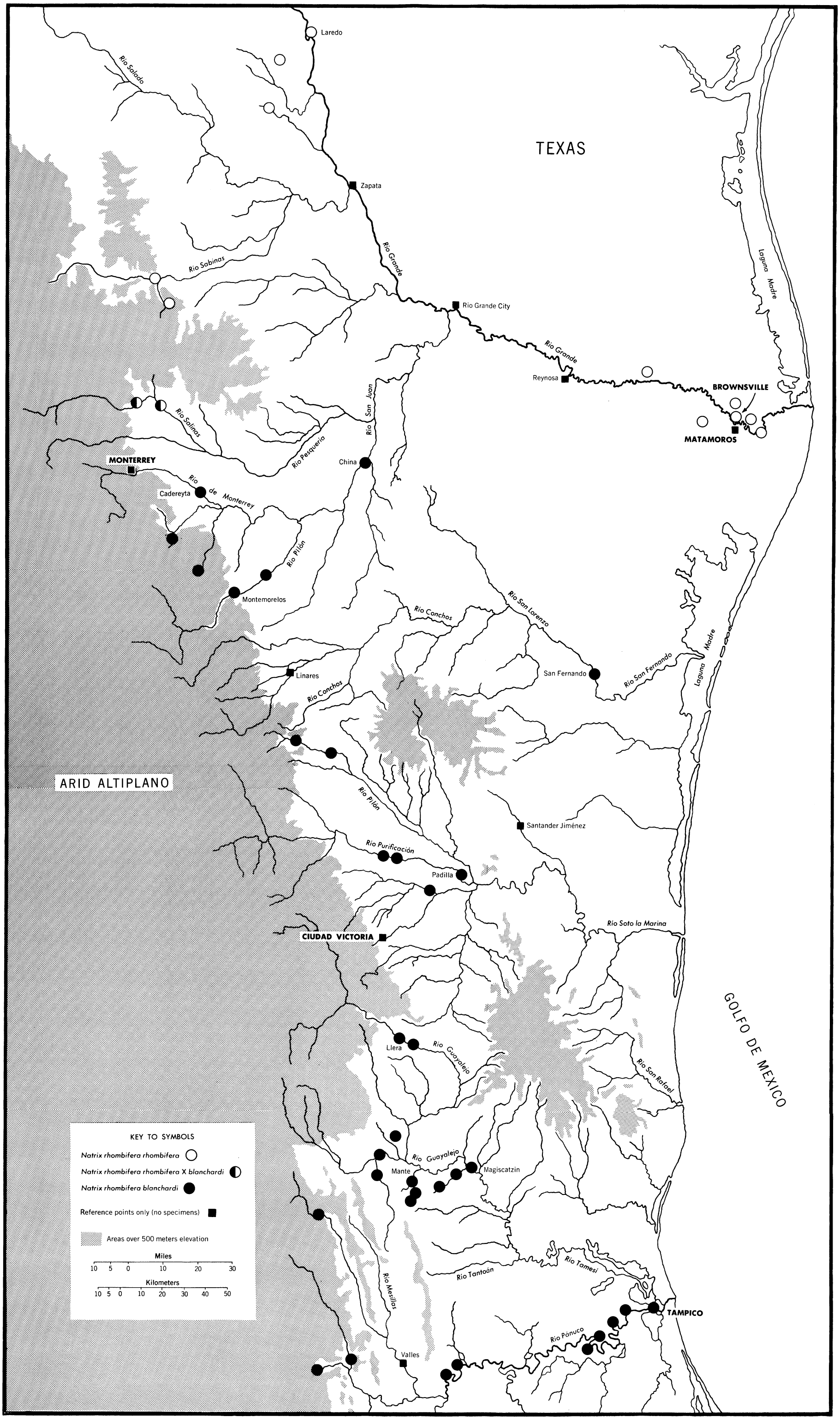
TAMAULIPAS, SAN LUIS POTOSÍ, OR VERACRUZ: Within 85 miles of Tampico between the Río Tamesí and the Río Pánuco (C.M. Nos. 9512–9515).

TAMAULIPAS: Ciudad Mante (U.S.L. No. 6611; L.S.U.M.Z. No. 10818); 7 miles east of Ciudad Mante (I.N.H.S. No. 9645); 16 miles east of Ciudad Mante (U.M.M.Z. No. 103185); 3 miles south of Ciudad Mante (I.N.H.S. No. 9665); immediately southwest of Ciudad Mante (E.D.A. Nos. 789–791; R.A.T. Nos. 1646, 1647; U.S.L. Nos. 6928–6946); 5 miles southwest of Ciudad Mante (L.S.U.M.Z. Nos. 10819, 10820); 7 miles north of El Limón (A.M.N.H. No. 88807); 5 miles west of El Limón (U.M.M.Z. Nos. 101226.1–101226.3, 101904–101907); Garza Valdéz (F.M.N.H. No. 2079); La Cruz, approximately 20 miles north of Ciudad Victoria at the Río Purificación (A.M.N.H. No. 81933); 1 mile east of Llera (T.C.W.C. No. 4126); Nuevo Veracruz, near Ciudad Mante (T.U. No. 15505); Padilla (B.C.B. Nos. 7534, 7535[1]); Río Corona, 10 miles southwest of Padilla (B.C.B. No. 11649[1]); Río Guayalejo, near Llera (U.I.M.N.H. Nos. 16855, 18632; T.U. No. 17768); Río Guayalejo, 2 miles north of Llera (A.M.N.H. Nos. 89136, 89137); Río Guayalejo near Magiscatzin (A.M.N.H. Nos. 89490–89494); Río Pilón, 8.5 miles north-northwest of Villagrán (U.M.M.Z. No. 126195); Río San Fernando at San Fernando (A.M.N.H. Nos. 89480–89489); Río Soto la Marina north of Padilla (T.C.W.C. No. 6549); Tampico (A.M.N.H. Nos. 89135, 93104; B.M.N.H. No. 93.1.9.19; S.U. No. 4365).

VERACRUZ: Seven and seven-tenths miles east of Cacalilao (U.M.M.Z. No. 114629); 19.3 miles east of Ebano (U.S.L. Nos. 6313, 6314, 6418–6421); Estero Cucharas, north of Citlaltepec (U.M.M.Z. No. 69259); near Pánuco (U.I.M.N.H. No. 18633); 5 miles north-northeast of Pánuco (T.N.H.C. No. 25063); 11 to 13 miles west of Tampico (A.M.N.H. Nos. 93100–93103, 93105); 16 to 17 miles west of Tampico (A.M.N.H. Nos. 88800–88806, 91111–91114, 93106); 16.1 miles west of Tampico (T.N.H.C. No. 25062).

The snakes from the collection of the British Museum (Natural History) labeled "Mexico," the embryos (E.A.L. Nos. 1239.1–1239.23), and a number of specimens received immediately prior to completion of the manuscript are not included in the sum-

[1] Reported as intergrades between *rhombifera* and *blanchardi* by Brown and Brown (1967, p. 325). They also reported an intergrade from the Río Purificación about 20 miles west of Padilla (B.C.B. No. 13827). This specimen was not available for my inspection, but on geographical grounds it would be *blanchardi*.



MAP 3. Locality records for members of the *Natrix rhombifera* complex in northeastern Mexico and the Rio Grande region of southern Texas. The streams are based chiefly on the Monterrey (1937) and San Luis Potosí (1932) sheets of the "Map of Hispanic America" (American Geographical Society). No attempt has been made to indicate the many impoundments, such as Presa de Don Martín, Presa El Azúcar, and Falcon Lake, that have been created since these maps were published.

marizations of meristic data, except as noted below.

Evidence of Possible Stream Capture

The apparent presence of two races of *rhombifera* and intergrades between them in the Río San Juan and its affluents in Nuevo León constitutes a unique situation. No other single drainage system, insofar as is known, is occupied by more than one subspecies of the diamond-backed water snake.

The distribution of the several populations in the San Juan system (map 3) may be summarized as follows: (1) *blanchardi* occupies the southernmost tributaries, including the Río de Monterrey and the Río Pilón; (2) intergrades (*rhombifera*×*blanchardi*) are represented in abundance from two collecting stations along the Río Salinas, a major branch of the Río Pesquería; and (3) *rhombifera* in all probability occupies the lowermost (northern) portion of the San Juan. Unfortunately, in the last case, no specimens are extant to offer proof, but *rhombifera* is known from a number of localities in or near the Rio Grande into which the Río San Juan discharges. Such an anomalous situation suggests the possibility of stream capture.

Recent field work has demonstrated the presence of *blanchardi* in the Río San Fernando in Tamaulipas, the first watercourse traversing the arid region south of the Rio Grande. This locality is in the San Lorenzo-Conchos-San Fernando drainage system, headwater arroyos of which (map 3) are in close proximity to the mainstream of the Río San Juan. The absence of high elevations between the two rivers and an examination of the direction of general stream flow in the region (sheets Nos. 22 [14R-VII] and 23 [14R-VI and 14R-VIII] of the sectional map published by the Ex-Comisión Intersecretarial [1958] and the 1:1,000,000 relief map issued by the Secretarío de Comunicaciónes y Obras Públicas [1956–1957]) suggest that the Río San Juan, in working headward, may have decapitated the westernmost tributaries of the San Lorenzo-Conchos-San Fernando system, with a concomitant transfer of the aquatic and semiaquatic fauna. Such changes would readily account for the presence of *blanchardi* in the Río de Monterrey and the other southern watercourses that are tributary to the Río San Juan. Downstream movement of the captive fauna presumably resulted in contact of *blanchardi* with *rhombifera* and the development of the intermediate populations.

There is evidence that at least one species of fish has a similar distribution. According to Robert Rush Miller (personal communication) the molly, *Poecilia mexicana*, is unknown from Rio Grande drainage except in the upper reaches of the Río San Juan. It does, however, occur at Linares in the Conchos-San Fernando system and might thus be another example of an organism transferred from one drainage to the other.

Detailed data on the distribution of the water snakes and other aquatic and riparian fauna in the system of the Río San Juan, which might lend further support to the theory of stream capture, must await additional field work. Speculation on approximately when piracy may have taken place is futile until supporting information is available from students of other disciplines, especially geology and climatology.

All specimens of *blanchardi* listed from Nuevo León (p. 64) are from the upper tributaries of the Río San Juan. All exhibit the pale, weak pattern that is characteristic of *blanchardi*. Among seven wild-caught individuals of this group with complete tails the number of subcaudals varies from 79 to 86 in males and from 70 to 72 in females. Among a litter of 23 nearly full-term embryos born to a snake from the Río Pilón at General Terán, Nuevo León, the number of subcaudals among 10 males varies from 80 to 84, mean 81.9; among 13 females, from 68 to 72, mean 68.9. All these counts are higher than the maximum numbers of subcaudals in the entire sample of the subspecies *rhombifera* from Mexico. There is thus no evidence of intergradation between *blanchardi* and *rhombifera* in the two principal characters (see below) for separating the two subspecies, and all material from the upper (southern) tributaries of the Río San Juan is readily referable to *blanchardi*.

Identification

The chief diagnostic characteristic of *blanchardi* is the great reduction in intensity of pattern in comparison with the strong, netlike markings of *rhombifera*, the loss resulting in part from the replacement of black

or dark brown pigment by gray or olive-gray and, in part, by a strong invasion of the dark scales by the pale ground color. Adults of *blanchardi* closely resemble specimens of *rhombifera* in which the dark pattern elements are obscured because of approaching ecdysis. Although the young of *blanchardi* (pl. 7, figs. 3 and 4) are fairly well patterned, adults are not. Their markings are usually faint, even shadowy, and in extreme cases they may be virtually absent, resulting in an almost uniformly colored snake. The belly may be plain yellowish, or it may be clouded with dusky markings along the lateral edges or bases of the ventrals, or both.

Also useful for identification is the tendency in some populations of *blanchardi* for the middorsal markings to be elongated, at least in some specimens. In some cases the elongation involves only the equivalent of a single blotch; in others several may be fused to form a dark, longitudinal, middorsal stripe.

The number of subcaudal scutes averages nine greater (in both sexes) in *blanchardi* than in *rhombifera* (table 2), and the tail is proportionally longer in *blanchardi*.

The characteristics of the three races of *Natrix rhombifera* are contrasted in chart 3.

In many instances, distinguishing between nearly uniformly colored specimens of *blanchardi* and those of *N. e. transversa* can be difficult even with the use of chart 1, especially if they have been long preserved and their coloration has faded. In such cases ancillary characteristics must be checked.

The two forms are sympatric in the southern tributaries of the Río San Juan. For example, M. H. Whisenhunt collected one of each in the Río Ramos at Allende, 20 kilometers northwest of Montemorelos, Nuevo León, during June, 1942. The specimen of *transversa* (T.C.W.C. No. 864) is an adult male with a head-body length of 750 mm.; the one of *blanchardi* (T.C.W.C. No. 882) is an adult female with a head-body length of 747 mm. Both snakes are virtually devoid of pattern and superficially so much resemble each other that they were both reported as *blanchardi* (Smith and Laufe, 1945, p. 350). When T.C.W.C. No. 882 is immersed in fluid, traces of the narrow, dark, longitudinal lines that are characteristic of many specimens of *blanchardi* are discernible on the middorsal row of scales. Also in this snake only one supralabial, the fourth, enters the eye, which is the normal condition in *blanchardi*. In T.C.W.C. No. 864 two supralabials enter the eye, as in most specimens of *transversa*. The head of the specimen of *transversa* is distinctly wider and stouter than the head of the specimen of *blanchardi*, although the two snakes are almost the same size in both length and bulk.

Scutellation

Scale counts in *blanchardi* may be summarized as follows: Ventrals in males, 139 to 150, mean 143.2; in females, 136 to 150, mean 141.1. Anal plate divided in all specimens. Subcaudals in males 76 to 88, mean 81.3; in females, 63 to 73, mean 68.6.

The most common dorsal-scale formula is 25–23–21–19, but 25–27–25–23–21 is also a frequent combination among females. A maximum of 27 scales occurs in 37 per cent of all females, but in only 5 per cent of the males; maxima of 26 rows occur in 17 per cent of the females and 5 per cent of the males; maxima of 25 rows occur in 46 per cent of the females and 90 per cent of the males. The minimum number of rows is 21 in 52 per cent and 19 in 35 per cent of the females; a count of 19 occurs among 82 per cent of the males. Minimum numbers of 20, 18, and 17 occur in a few specimens, but all those below 19 are in males.

Dorsal-scale increases and reductions among four males with maxima of 25 rows are:

23 5+6 or 4+5 (27–53)—*25* 5+6 (59–72)—*23* 4+5 or 5+6 (75–89)—*21* 4+5 or 9+10 (in one snake) (87–110)—*19* (140–144)

Dorsal-scale reductions among four females with maxima of 25 rows are:

25 5+6 or 6+7 (66–72)—*23* 4+5 (85–87)—*21* 4+5 (110–122)—*19* (136–139)

Scale increases and reductions among four females with maxima of 27 rows are:

25 5+6 or 6+7 (28–41)—*27* 5+6 (56–68)—*25* 5+6 (76–91)—*23* 4+5 or 5+6 (96–112)—*21* (137–142)

Supralabials usually eight, but seven in 10 per cent of the cases; infralabials usually

11 or 10, rarely 12 or nine. Almost invariably a single preocular, rarely two; postoculars usually three, but in some cases four. Invariably a single anterior temporal; temporals in second row two, in some cases three, but only one in three cases. The fourth supralabial enters the eye in the great majority of instances. In 12.5 per cent of the cases, however, the lowermost postocular extends forward beneath the eye to meet the preocular, thus cutting the supralabial off from the orbit. In an additional 11 per cent of the counts the oculars nearly touch and the supralabial barely makes contact with the orbit. Both conditions, lack of contact or only slight contact between the orbit and the supralabial, may occur on both sides of the head in individual snakes or on only one side. In the population samples available the supralabial is cut off from the orbit only among snakes from near the Gulf coast (see section on irregularities below). On the contrary, the supralabial narrowly meets the orbit among snakes from widely scattered localities throughout the range of *blanchardi*.

Irregularities in Scutellation

Counts of seven supralabials occur occasionally among specimens from scattered localities, but in at least two areas they are more frequent. Among seven specimens from the Río Soto la Marina and its tributaries in Tamaulipas, counts of seven occur five times and the normal number of eight occurs nine times. Among 14 snakes from the vicinity of Tamazunchale, San Luis Potosí, a count of seven occurs nine times, and the number is reduced to six on one side of the head in one specimen; counts of eight occur in all other cases in this sample. In almost every instance the reduction is the result of fusion or partial fusion of the last two supralabials.

The supralabials are completely excluded from the orbit among snakes from three different coastal areas: (1) Among 10 specimens from the Río San Fernando the supralabials are excluded nine times (in a total count of 20); these snakes are all from a single locality, and nine of them are young of the year. (2) Among 12 counts made on snakes from several localities from the *cuenca* of the Río Soto la Marina there is no contact in three instances. (3) Among 52 counts on specimens from the vicinity of Tampico there is no contact in seven.

Coloration and Pattern

The dorsal view of the head, a lateral view at midbody, and a ventral view at midbody of an adult male are illustrated in color (pl. 1, fig. 3). The colors shown are from an individual that was paler in life than the majority of members of this taxon.

Among adults, the dorsal ground color varies from buff to dark olive (Olive-Buff to Deep Olive) in the middorsal area; the ground color on the sides of the body usually is slightly paler. The dorsal markings, which basically occupy the same areas and are about as numerous as the strongly defined markings in the subspecies *rhombifera*, are gray or pale olive, and they vary in their degree of contrast with the ground color. In some specimens of *blanchardi* they are barely discernible, and the over-all effect is that of an almost uniformly colored snake. In other individuals the markings are considerably more apparent, but even in these the dark dorsal blotches and the lateral bars (so strongly evident in *rhombifera*) are greatly subdued. The diagonal markings that connect the dorsal and lateral markings in *rhombifera* are sharply reduced in *blanchardi*, or absent. The ground color of the venter in *blanchardi* is buff or dull yellow, but in many adults the anterolateral portions of the ventrals are clouded or dusted with gray or olive-gray. The under side of the tail is similar, but darker, and the dark coloration also is concentrated along the midline of the subcaudals to form a narrow, irregular, dusky stripe.

In some specimens there is a strong invasion of the ventral surface by mottled, clouded, or stippled light gray pigment similar to, but usually paler than, the lateral ground color. An extreme example occurs in L.S.U.M.Z. No. 10816, a female measuring 871 mm. in total length from east of Tamuín, San Luis Potosí. In this snake the dark coloration involves almost the total area of each ventral, and the normal yellow coloration of the belly is restricted to a small area near the center of the posterior edge of each ventral scute. The amount of dark pigment

decreases anteriorly, but only about the first 20 ventrals are chiefly yellow.

The dorsal pattern is much more strongly defined in juveniles, but the dark dorsal and lateral markings are deeply invaded by the ground color. As in *rhombifera*, the bellies of the young of *blanchardi* often are washed down their centers with orange or reddish tones, but, unlike young *rhombifera*, juveniles of *blanchardi* have few if any ventral markings except near and under the tail and at the extreme lateral edges of the ventrals.

The general coloration of a large adult male (total length, 920+ mm., with tip of tail missing) from the Río Guayalejo, near Magiscatzin, Tamaulipas, may be summarized as follows: Dorsal ground color, including sides of body, top of head, and supralabials, olive (Citrine-Drab), but slightly darker in the middorsal region on the posterior part of body. Dorsal markings slightly darker (Deep Olive), and scarcely distinguishable from the ground color. Chin, throat, and infralabials buffy yellow (Naples Yellow). All labial sutures Dark Olive. Ground color of belly buffy yellow (Colonial Buff) on anterior half of body and gradually changing to Olive Buff posteriorly and under the tail. The anterolateral portions of each ventral bear dusky markings of Grayish Olive that occupy a large part of each scale, at least on the posterior two-thirds of the body and under the tail. Eye: Pupil black, narrowly edged in part by yellow; iris Deep Olive with scattered, slightly paler areas. Tongue: Very dark gray, tips slightly paler.

In a somewhat smaller adult male (total length, 730 mm.) from 17 miles west of Tampico, Veracruz, the dorsal markings are more discernible. In this snake the ground color is Deep Olive in the middorsal region and Citrine-Drab on the sides of the body. The middorsal markings, which are poorly defined and irregular, are dark gray (paler than Chaetura Black), and they tend strongly to be elongated and to fuse into longitudinal stripes. The lateral blotches are weak and poorly defined. The ground color of the belly is yellowish, and the center of the ventral area is washed with Amber Yellow throughout most of its length.

Juveniles, as in all races of *N. rhombifera*, are more strongly marked than adults of their respective subspecies. The coloration of a young female (total length, 355 mm.) from the Río San Fernando, at San Fernando, Tamaulipas, may be summarized as follows: Dorsal ground color Grayish Olive, changing to Light Grayish Olive on sides of body. Darker portions of dorsal and lateral markings dark olive (Olivaceous Black 1); pale portions, which occupy much more than half of each scale on the sides of the body, Buffy Brown. Top of head dull olive (Citrine-Drab), with darker areas of Deep Olive to Dark Olive. Supralabials Olive-Buff. Labial sutures Sepia. Chin, throat, and infralabials yellowish cream. Belly Olive-Buff, but midventral area from near throat to anal region washed with cinnamon-pink (Japan Rose). Under side of tail Deep Olive-Buff, washed down its center by pinkish gray (Avellaneous). Belly unmarked except where the lateral markings (Dark Olive) encroach on edges of ventrals. Under side of tail Olive-Buff marked with Dark Olive half moons and a center line of Citrine-Drab. Eye: Pupil black, narrowly ringed by yellow; iris medium brown (Snuff Brown). Tongue: Upper surface heavily stippled with black on brown so that over-all appearance is almost black; ventral surface dull reddish brown at base, darker at tip.

The middorsal blotches, which are weak or even absent in the subspecies *blanchardi*, were discernible enough to be counted in only 77 specimens. They vary from 24 to 35, with a mean of 29.4.

Longitudinal Striping

There is a strong tendency among some populations of *blanchardi* for the middorsal markings to be elongated longitudinally. In some snakes only a single marking may be elongated, but in others many are involved; in extreme cases several may be fused together to form longitudinal, middorsal, dark stripes.

In a series of 10 specimens from San Fernando, Tamaulipas, which includes an adult male and nine juveniles, elongation of at least one marking occurs in all but two specimens. Two markings are fused together (at different parts of the body) in four specimens, and in two others there are numerous elongations (pl. 7, fig. 3).

An extreme case of longitudinal striping occurs in C.M. No. 9513, an adult male from the general vicinity of Tampico. In this snake the tenth middorsal marking is elongated. The eleventh is continuous for an uninterrupted length of 45 scales in the form of an almost straight dark stripe involving the middorsal row of scales and narrow edges of the adjacent scales. The stripe obviously represents the fusing of a considerable number of dark markings. The posterior nine or 10 markings in this snake, although separated from one another, are all elongated except for the final one. The over-all effect of the long-preserved specimen is of a khaki-colored snake with a rather dark middorsal stripe extending most of the length of the body, but interrupted intermittently near the tail.

The tendency toward elongation of markings, based on the samples available, appears to be most evident in the Río San Fernando, in parts of the Río Guayalejo drainage, and in the general vicinity of Tampico.

Size and Sex

The 10 largest females have measurements as follows: Head-body length, 1068 mm. (total length 1358 mm.); 1060 mm. (1335+ mm.); 890 mm. (1130 mm.); 877 mm. (1074+ mm.); 837 mm. (969+ mm.); 812 mm. (1047 mm.); 783 mm. (1015 mm.); 780 mm. (1020 mm.); 747 mm. (970 mm.); and 692 mm. (913 mm.). Comparable measurements for the 10 largest males are: 780 mm. (940+ mm.); 763 mm. (1019 mm.); 713 mm. (970 mm.); 708 mm. (947 mm.); 707 mm. (963 mm.); 707 mm. (926+ mm.); 703 mm. (906 mm.); 694 mm. (956 mm.); 690 mm. (920+ mm.); and 683 mm. (884+ mm.).

No data are available on newborn young. No litters were born in captivity. Among juveniles collected in the field, the six smallest vary from 253 to 294 mm. in total length, and they are thus comparable in size with juveniles born to several Mexican females of the *rhombifera* complex (see table 20).

Tail length/total length ratios for males of all sizes are 0.24 to 0.28, mean 0.264; for females, 0.21 to 0.25, mean 0.235.

Intergradation with *werleri*

Lack of adequate material negates the possibility of defining the area of intergradation between *blanchardi* and *werleri* with any degree of precision, but six specimens from coastal and nearby localities in central Veracruz suggest that it may occur from the vicinity of Tecolutla to the vicinity of José Cardel. This is the region where the Sierra Chiconquiaco and associated highlands extend eastward to the Gulf of Mexico as an immense volcanic salient of the Mesa Central that "divides the Gulf lowland into a northern and southern sector" (West, 1964, p. 58). There is thus only a tenuous contact between the populations of *blanchardi* that range widely to the north and those of *werleri* that range far to the south.

Locality records for the snakes considered to be intergrades between *blanchardi* and *werleri* are:

Veracruz: Two miles north of José Cardel (M.V.Z. No. 76374); La Palmilla, Canton de Jalacingo, 25.5 kilometers north-northeast of Teziutlán (A.M.N.H. Nos. 4293, 4294); 11 miles east-northeast of Martínez de la Torre (U.I.M.N.H. Nos. 3841, 3842); 4 miles west of Tecolutla (U.M.M.Z. No. 105106). Elevations for these several localities range from virtually sea level at Tecolutla to 462 meters (1516 feet) at La Palmilla (see p. 18).

Cope (1885, p. 382; 1900, p. 965) and Ferrari-Pérez (1886, p. 186) mentioned a specimen from Misantla, Veracruz, that probably also was an intergrade, but it presumably has been lost. Enrique Beltrán, of the Instituto Mexicano de Recursos Naturales Renovables, made a recent unsuccessful attempt to trace the whereabouts of the Ferrari-Pérez collection (Hobart Smith, personal communication).

All of these snakes are small, and two probably are newborn young. They exhibit considerable variation, ranging from relatively strongly patterned (as in *werleri*) to weakly patterned (as in *blanchardi*), and some have two preoculars (as in *werleri*), whereas others have only a single preocular (as in *blanchardi*). The following combinations of characters are seen among these specimens (localities arranged roughly from north to south): Tecolutla (weak pattern, two preoculars); Martínez de la Torre (relatively weak pattern, two preoculars in one specimen and one preocular in the other); La Palmilla (fairly strong pattern, two pre-

oculars in one and one preocular in the other); and José Cardel (weak pattern, two preoculars). There is thus no consistent trend from one subspecies to the other, and the most that can be said for this small group of snakes is that, collectively, they exhibit characteristics of both forms. A better understanding of intergradation between the two races must await the acquisition of more material.

A specimen (F.M.N.H. No. 2039) collected at La Antigua, Veracruz, a short distance farther south along the coast, has a typical *werleri* pattern, with the middorsal markings almost solid black and with strong indications of dark ventral half moons. In this snake each preocular, although single, is crossed by a groove in the position where a suture is normally present in most specimens of *werleri* (to give them a count of two). A large adult female (U.M.M.Z. No. 121694), from 2 miles south of the city of Veracruz, also has a strong *werleri* pattern, but it has only a single preocular (as in 20% of the counts in the subspecies *werleri* as a whole). Tentatively, I have classified both snakes as *werleri*, although I anticipate that at least the La Antigua locality may eventually be found to lie within the zone of intergradation between *blanchardi* and *werleri*.

Ecology and Natural History

Natrix rhombifera blanchardi is an abundant snake in many localities, and it probably is one of the most common vertebrates in the vast and complex delta system associated with the Ríos Pánuco and Tamesí in the general vicinity of Tampico. The names of two bodies of water of the region, Lago La Culebra and Lago Tortuga, suggest the abundance of semiaquatic reptiles. Most specimens were found at night, either along streams or on roads passing through swampy areas.

Several zones of vegetation are present within the geographical range of *blanchardi*. Thorn forest occurs at lower elevations on all sides of the uplands of the Sierra de Tamaulipas, and it extends southward along the coast beyond Tampico. Farther inland and at higher elevations tropical deciduous forest and tropical evergreen forest are present, and a long, narrow tongue of mesquite-grassland extends southward from the north between the Sierra Madre Oriental and the Sierra de Tamaulipas (Leopold, MS).

Rainfall is moderate, with annual totals of 902 mm. and 1252 mm. reported at Ciudad Victoria and Tampico, respectively. The greatest amount of precipitation falls from May to October, inclusive, at Ciudad Victoria (June to October at Tampico), with a peak in September at both stations. Contreras Arias (1942), the source of these climatological data, characterized the climate at both stations as semiarid and warm, without a definite winter season. The mean annual and highest recorded temperatures (the latter in parentheses) listed were: Ciudad Victoria, 22.7° C. (41.7° C.); and Tampico, 24.3° C. (39.8° C.). Agriculture, much of it aided by irrigation, is widely practiced, and *blanchardi* is commonly found in canals, especially those that have become weed-choked and thus provide good shelter.

The following notes are based on our field experience during the early evening hours along the Ríos Guayalejo, Moctezuma, and San Fernando and in the general vicinity of Tampico.

Four small water snakes were collected along the Río Moctezuma in the vicinity of Quinta Chilla a short distance upstream from Tamazunchale, San Luis Potosí, on October 4, 1949, and an additional three were taken at the same locality on October 22, 1949. All were in shallow water or on a small, grass-covered island close to shore. Most were in small clumps of weeds at the edge of the current; the river was flowing rapidly but was not in flood on either evening. One of the snakes was floating at the surface in 3 feet of water, but it was in a brush pile, with the posterior part of the body and the tail entwined around a twig. Two others were lying on a muddy bottom in water about 2 inches deep. All seven snakes presumably were young of the year; they varied from 368 mm. to 494 mm. in total length.

Nine young of *blanchardi* were collected at San Fernando, Tamaulipas, in the Río San Fernando (also known as the Río Conchos) on August 23, 1962. All were prowling in shallow water; three were at riffles where there was a slight current, but the others were in quiet pools along the edge of the

stream. These snakes, also all presumably young of the year, measured 340 mm. to 478 mm. in total length. A large adult male was also caught, in shallow water but close to a deep pool. The river was low, but it showed evidence of having been higher a short time previously, probably under the influence of runoff from rains upstream; the general area surrounding San Fernando was parched. *Rana pipiens* was abundant in the stream bed, *Bufo valliceps* was calling in small numbers, and *Bufo marinus*, a species that we had encountered a day or two previously in many localities farther south, was conspicuously absent.

Five specimens of *blanchardi* of assorted sizes were taken in the Río Guayalejo near Magiscatzin, Tamaulipas, on August 22, 1962. Three were prowling in low, emergent vegetation close to shore, but two large ones swam past my feet as I stood at the base of a steep bank that descended sharply into deep water. The larger snake, which was in excess of 900 mm. in length and exceeded the smaller one by more than 200 mm., appeared to be in pursuit of the other, for it rapidly closed the gap between them and bit at the smaller snake just before I caught them. Both were males. No other snakes of any kind were seen on the same side of the river, which was wide and flowing with considerable current, and no further evidence was obtained to indicate whether the pursuit and biting activities resulted from sexual stimulation such as that suggested for other members of the genus *Natrix* by Tinkle and Liner (1955).

During the evening of August 20, 1962, we found a "snake crossing" on the highway in Veracruz (Mexico No. 110) approximately 17 miles west of Tampico where many water snakes had been killed by the relatively heavy truck traffic. We returned to the same locality during the late afternoon of the following day to take photographs (pl. 17, fig. 1), and to make notes on the general habitat. The area on both sides of the road was marshy, and a broad borrow ditch paralleling the north side of the road was teeming with small fishes. A short distance beyond were several small ponds, the surfaces of which were coated with oil, but these evidently were avoided by the snakes, for none of them, alive or dead, was oily. A very large pasture, where many horses were grazing, occupied an extensive area on the south side of the highway. A few hundred yards farther west the highway bridged a deep but rather narrow stream, but no snakes were seen near it, although we searched along it after dark. We failed to determine why the snakes, all of adult size and of both sexes, were concentrated in a small area; they appeared to be crossing the highway in both directions.

Although we began our patrol at dusk, several snakes had already been killed. A few live ones were caught on the road shoulders as they were crawling parallel to the paving. The weather was clear and humid, with air temperatures approximating 30° C. during the afternoon and dropping to about 25° C. after dark.

We patrolled the same highway again during the evenings of July 1 to 3, 1964, and, although we collected seven additional specimens of *blanchardi*, there was no concentration of them as there had been in 1962. The snakes were found at scattered localities, most of them nearer Tampico, including one juvenile that crawled across the paving within a few feet of the toll gate at the bridge crossing the outflow stream from the Laguna de Chairel.

Other snakes collected along the same highway, and all of which were associated with *blanchardi*, in that they were found in the same localities, included *Boa constrictor imperator*, *Elaphe guttata emoryi*, *Lampropeltis triangulum polyzona*, *Coniophanes imperialis imperialis*, *Leptodeira annulata cussiliris*, *Storeria tropica temporalineata*, *Thamnophis marcianus marcianus*, and *Thamnophis proximus rutiloris*. Among these the ribbon snake, *T. proximus*, was abundant, and was the most common snake encountered in the area during the 1964 field work.

Several other persons have found *blanchardi* abundant in this general region, including Edmund D. Keiser, Jr. He encountered "quite a few" immediately west of Tampico (personal communication), and, during a drizzling rain about 3:45 A.M. on August 17, 1967, counted 124 snakes dead on the road approximately 19 miles east of Ebano, most of them *Natrix*. The collecting

party of which he was a member also obtained series of specimens near Ciudad Mante and Ciudad de Valles, in Tamaulipas and San Luis Potosí, respectively.

The attrition on the water-snake populations must be high during the summer months. Our observations in many parts of Mexico indicate that they are most active and apt to cross the roads at night when traffic, consisting largely of trucks, is heaviest. Both the snakes and the Mexican drivers take advantage of the cooler hours of darkness for their activities.

Through the kindness of Señor Roberto Villaseñor, of Tampico, we were privileged to visit his boat club and to explore some of the waterways associated with the Laguna de Chairel on October 24–25, 1949 (pl. 17, fig. 2). Only one snake was caught, a large adult male found at high tide near the boat club in an area that was bare mud the next morning. Evidence that the water in the area was brackish was attested by Villaseñor's statement that boats and pilings become covered with barnacles within a few months' time. He also told us that water snakes were commonly seen in the fresh water of the canals associated with the *laguna*.

Other collectors have reported finding *blanchardi* under rocks along streams, and "in a spring." Fred G. Thompson (personal communication) reported that "at Tamasopo and Rascón [San Luis Potosí] snakes were abundant sunning on rocks and logs. At both places the rivers were about 50–100 feet wide, and consisted of alternating deep, clear holes and shallow gravel rapids. At Rascón the river was lined with large cypresses. At Tamasopo the river was lined with figs and other broadleaf trees. At San Felipe the snakes were found under rock in shallow pools."

Captives fed voraciously on *Rana pipiens* and a variety of small fishes. An adult stoneroller, *Campostoma anomalum*, was found in the stomach of a large individual of *blanchardi* collected in the Río de Monterrey near Cadereyta, Nuevo León. Robert R. Miller, who made the identification, stated (personal communication) that this species of fish reaches the southern limit of its range in the Río San Juan basin, of which the Río de Monterrey is a part.

Natrix rhombifera werleri Conant

TABASCO WATER SNAKE

Plate 1, figure 4, plate 8, figures 1–6

Natrix rhombifera werleri CONANT, 1953, p. 4.

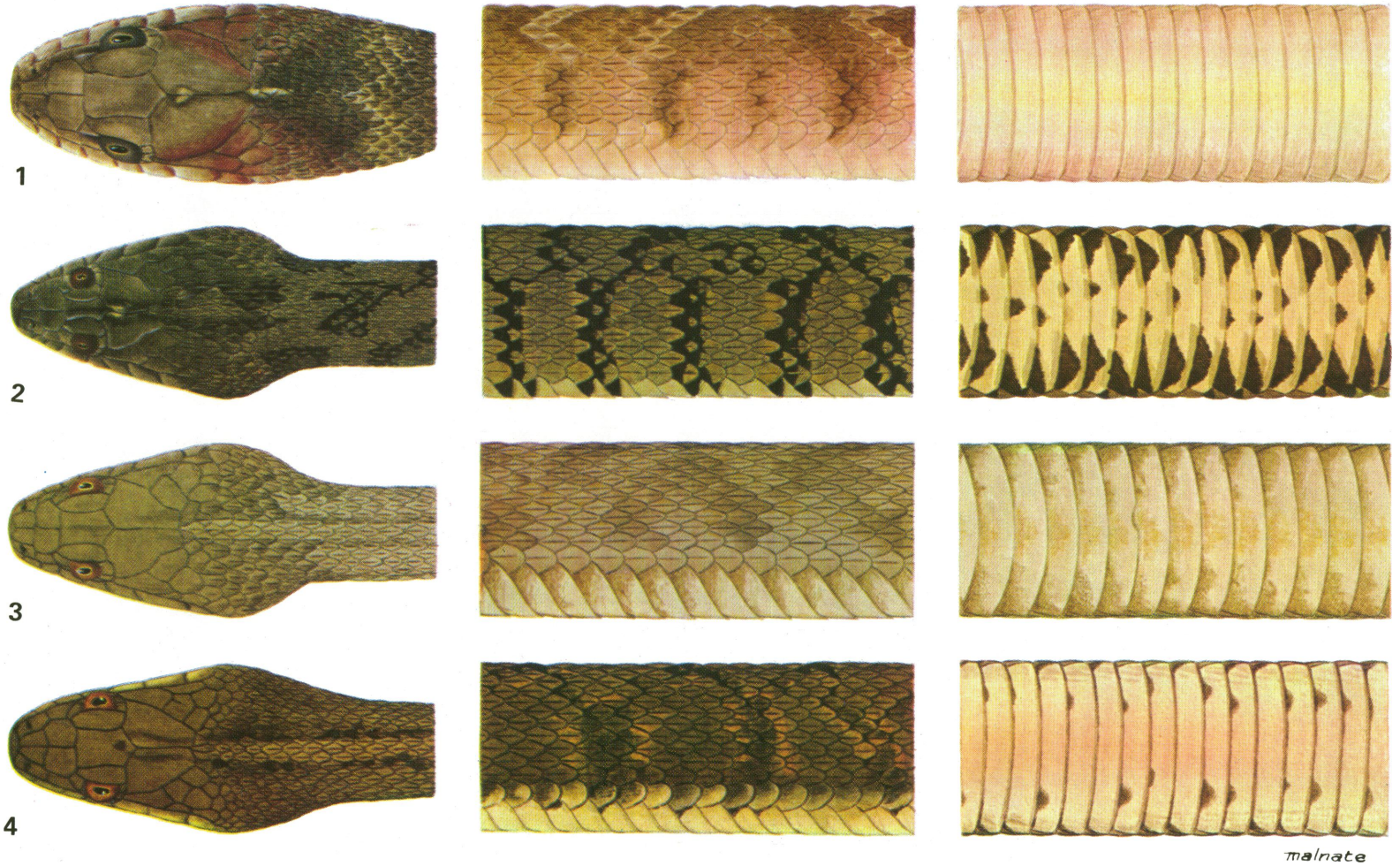
TYPE AND TYPE LOCALITY

U.I.M.N.H. No. 67067, formerly F.A.S. No. 3333, holotype, a young adult male collected on the Alvarado-San Andrés Tuxtla road (Mexico No. 180), approximately 18 miles southeast of Alvarado, Veracruz (Conant, 1953, p. 4).

RANGE

Lowland portions of Veracruz southeastward from the vicinity of La Antigua; eastward through Tabasco to adjacent parts of Campeche, Chiapas, and (probably) Oaxaca. This race of the *rhombifera* complex undoubtedly is much more widely distributed than the records would indicate. A very large part of the great swamplands that center on Tabasco is inaccessible except by boat, and many of the available records, as is suggested by the beadlike rows of symbols on map 2, are from along some of the few highways that traverse the region. Additional localities may accrue rapidly as new roads are opened to traffic. Some comments on probable distributions are:

CAMPECHE: The only record for this state is from the Río San Pedro y San Pablo, where the river forms part of the boundary with Tabasco. The region farther eastward contains vast swamps and many rivers emptying into the Gulf of Mexico or the Laguna de Terminos, and much of the area should be prime habitat for a strongly aquatic snake like *werleri*. Partial proof may come when concentrated field work is undertaken along the new highway to Yucatán that runs eastward from Villahermosa to near Emiliano Zapata and then northward to Campeche. It is probable that *Natrix* does not occur in eastern or northern Campeche or in the remainder of the Yucatán Peninsula where there are no surface streams. On the other hand, *Thamnophis proximus rutiloris*, with which this water snake is sympatric throughout coastal Veracruz and Tabasco, has been taken in several localities in Yucatán and Quintana Roo (Rossman, 1963, p. 111), and including at least one in brackish water



Coloration in Mexican water snakes. *Left to right:* Dorsal views of heads, lateral views at midbody, and ventral views at midbody. 1. *Natrix erythrogaster bogerti,* female, A.M.N.H. No. 73164, 774 mm.; Río Nazas near La Goma, Durango. 2. *Natrix rhombifera rhombifera,* female, A.M.N.H. No. 89065, 1134 mm.; Ojo de Agua, 4 miles west of Sabinas Hidalgo, Nuevo León. 3. *Natrix rhombifera blanchardi,* male, A.M.N.H. No. 89135, 860 mm.; Tampico, Tamaulipas. 4. *Natrix rhombifera werleri,* type, male, U.I.M.N.H. No. 67067, 787 mm.; 18 miles southeast of Alvarado, Veracruz

in mangrove swamps near Progreso (Ruthven, 1908, p. 98).

CHIAPAS: The only specimen extant from Chiapas was taken at Playas, within 35 miles of Palenque, but the potential for adding records from that state are high. It must occur in many of the swamps and rivers. For example, there is a record from Emiliano Zapata, Tabasco, which is on the Río Usumacinta which forms part of the boundary between Chiapas and Tabasco. Also a northern arm of Chiapas extends to within 30 miles of the Gulf coast near Cárdenas and presumably well within the range of *werleri*.

OAXACA: This water snake occurs abundantly in the lower portions of the Ríos Papaloapan and Coatzacoalcos and their associated swamps. Both rivers, as well as many others of the same general region, rise in Oaxaca and traverse lowland areas in that state on their way to the Gulf of Mexico, and it is virtually certain that *werleri* will eventually be found in a number of localities in Oaxaca.

Whether *Natrix* enters Guatemala is unknown. Localities reported in error from Central America are discussed on page 6.

All recorded stations for *werleri* fall below the 200-meter contour, but it is possible that this water snake also occurs in some of the rivers at localities well above that elevation.

Intergradation with *blanchardi* takes place north of La Antigua, Veracruz (see pp. 69–70).

The locality records and museum numbers for 77 specimens studied in detail are:

"MEXICO": (B.M.N.H. No. 59.9.20.22).

CAMPECHE: Near Kuyuko Landing, about 15 miles south of Boca San Pedro on the Río San Pedro y San Pablo (A.M.N.H. No. 85073).

CHIAPAS: Playas, within 35 miles of Palenque (A.M.N.H. No. 99656).

TABASCO: Twenty miles southwest of Frontera (B.C.B. No. 11646); Río Usumacinta at Monte Cristo Emiliano Zapata (U.S.N.M. No. 110511); 2.5 miles east of Teapa (U.M.M.Z. No. 126196); 15 miles north of Teapa (L.S.U.M.Z. No. 6858); 8 miles north-northeast of Villahermosa (I.N.H.S. No. 9600); 18 to 19 miles north-northeast of Villahermosa (A.M.N.H. Nos. 88796–88798); 23 miles northeast of Villahermosa (B.C.B. No. 11645); 1 mile south of Villahermosa (A.M.N.H. No. 88795); 4 miles south of Villahermosa (U.M.M.Z. No. 113763).

VERACRUZ: Alvarado (C.M. No. 38914; M.C.Z. Nos. 16005, 16006); 0.8 mile to 6.6 miles east-southeast of Alvarado (U.M.-M.Z. Nos. 114606, 114607, 114611–114615, 114661); 5 miles east-southeast of Alvarado (U.I.M.N.H. No. 33859); 11 miles east-southeast of Alvarado (T.C.W.C. Nos. 19154, 21937); 18 miles southeast of Alvarado (A.M.N.H. No. 73481; U.I.M.N.H. Nos. 67067, 74457, 74458); 1 mile west-northwest of Alvarado (M.M.N.H. No. 2119); 7.9 miles west-northwest of Alvarado (U.F. No. 11308); 3.2 miles south-southwest of Amatitlán, near Cosamaloapán (U.M.M.Z. No. 114621); Buena Vista, 10 miles southeast of Alvarado (A.M.N.H. No. 92739); 1.6 and 2 miles east of Ciudad Alemán (U.M.M.Z. Nos. 114616, 114617); 2 to 9 miles southwest of Coatzacoalcos (A.M.N.H. Nos. 88799, 93107–93112); 1 mile north-northeast of Cosamaloapán (A.M.N.H. No. 88792); 1.2 and 1.5 miles north-northeast of Cosamaloapán (U.M.M.Z. Nos. 114622, 114623); La Antigua (F.M.N.H. No. 2039); near Lerdo de Tejada (T.C.W.C. No. 19154); 1.5 and 2.1 miles northwest of Lerdo de Tejada (U.M.M.Z. Nos. 114608, 114609); 15 miles northwest of Lerdo de Tejada, opposite Buena Vista ferry (C.M. Nos. 41474, 41475); 4 kilometers west of Minatitlán (C.M. No. 41473); 4 to 5.6 miles southwest of Novillero, near Ciudad Alemán (U.M.M.Z. Nos. 114618–114620, 114659); Paso Nacional (U.M.M.Z. No. 114610); Río Coatzacoalcos, 10 miles upstream from Minatitlán (M.V.Z. No. 59755); Río Culebra, 1 mile east and 1 mile or 2 miles south of Tlacotalpán (M.M.N.H. Nos. 2452, 2453); Río San Augustín, Tecolapia, 17 miles southeast of Alvarado (U.U. Nos. 3933, 3934); 9 miles north-northwest of Santiago Tuxtla (M.M.-N.H. No. 2283); 10 miles northwest of Santiago Tuxtla (U.I.M.N.H. Nos. 55023, 55024); Tlacotalpán (U.S.N.M. No. 46533); 8 and 9 miles east-northeast of Tlacotalpán (C.M. Nos. 38913, 39469); 4 miles north-northeast of Tlacotalpán (T.N.H.C. No. 26934); 8 miles north-northeast of Tlacotalpán (M.M.N.H. No. 2509); 2.4 miles south-southwest of Tlacotalpán (U.M.M.Z.

No. 114660); 9 and 11 miles south-southwest of Tlacotalpán (A.M.N.H. Nos. 88793, 88794); 2 miles south of Veracruz (U.M.M.Z. No. 121694).

A large adult, found dead on the road 9 miles west of Cosamaloapán, Veracruz, was not preserved.

Dùges (1894, p. 376) listed *Natrix rhombifera* from Macuspana and *Natrix fasciata transversa* from Tepetitán, both in Tabasco. On geographical grounds both snakes would be *werleri*, but confirmation, if the specimens are still extant, would necessitate a visit to the Museo Alfredo Dùges at the Universidad de Guanajuato. In a later paper Dùges (1896, p. 481) again listed the same two snakes (the one from Tepetitán as *Natrix transversa*). Smith and Taylor (1945, p. 155) included both localities under *Natrix rhombifera rhombifera*.

Identification

Adult specimens of *werleri* are similar in general appearance to adults of *rhombifera*. In *werleri*, however, the middorsal markings are chiefly solid black or dark brown, with little invasion of the dark scales by the ground color. In contrast, the lateral dark markings are less conspicuous, and the dark scales composing them may be deeply invaded by the pale ground color. There are usually some dark markings on the venter, but these vary clinally and are darker, more numerous, and therefore more conspicuous in specimens from the far southern and eastern portions of the range.

There are usually two or (rarely) three preoculars in *werleri* instead of one. Among the sample of *werleri* there are two preoculars in 76 per cent of all the counts (two counts for each snake), three among 5 per cent, and one among 19 per cent. By comparison a count of one occurs in 97 per cent of the specimens of *blanchardi* and 96 per cent of those of *rhombifera* (see table 9).

The chief diagnostic characteristics of the several races of *rhombifera* are indicated in chart 3.

Scutellation

Scale counts in *werleri* may be summarized as follows: Ventrals in males, 137 to 145, mean 141.4; in females, 135 to 142, mean 138.5. Anal plate divided in all specimens. Subcaudals in males, 78 to 86, mean 82.2; in females, 64 to 73, mean 68.0.

The most frequent dorsal-scale formula in both sexes is 25–23–21, but there are many other combinations, a considerable number of which include counts of 27 rows. A maximum of 27 rows occurs among 61 per cent of all females, but only 28 per cent of the males; maxima of 25 rows occur among 36 per cent of the females and 64 per cent of the males. The minimum number of rows is 21 among 83 per cent of the females and 56 per cent of the males; minima of 19 occur among only 6 per cent of the females, but 31 per cent of the males. There are a few minima of 20 and one of 23 in each sex.

Dorsal-scale reductions among four males are:

25 5+6 (73–81)—*23* 5+6 or 4+5 (92–100)—*21* (140–144)

Reductions among four females with maxima of 25 rows are:

25 5+6 or 6+7 (70–84)—*23* 4+5 or 5+6 (94–104)—*21* (137–138)

Increases and reductions in two females with maxima of 27 rows are:

25 +6 and +13 (paravertebral rows in one snake) (41–54)—*27* 6+7 and 12+13 (in same snake) (58–60)—*25* 5+6 (77–86)—*23* 5+6 or 4+5 (99–107)—*21* (139–140)

Supralabials eight, rarely nine; infralabials 11 in most cases, but 12 in some, 10 in a few, and rarely 13 (one count only). Preoculars normally two, rarely three; a single preocular occurs in 19 per cent of the counts. Postoculars three in most cases, but four in many. Normally a single anterior temporal, but a count of two occurs in many cases; secondary temporals two in most cases, but three in many, and increased to four in a single case. The fourth supralabial in most cases enters the eye, but in 20 per cent of the counts the lowermost postocular and preocular meet beneath the eye, thus separating the supralabials from the orbit. In an additional 27 per cent of the counts the oculars nearly touch, but not closely enough to prevent the supralabial from making a narrow contact with the eye. As in *blanchardi* either

condition may occur on both sides or on only one side of the head in individual specimens.

There is a marked tendency for the scale counts in many categories to average higher than they do in the subspecies *blanchardi* (see p. 55).

Coloration and Pattern

The dorsal view of the head, a lateral view at midbody, and a ventral view at midbody of the holotype, a young adult male, are illustrated in color (pl. 1, fig. 4). Details on the coloration of the entire animal were included in the original description (Conant, 1953, p. 6).

Among adults the dorsal ground color varies from brown (Saccardo's Umber) to olive in the middorsal area to various shades of paler brown or olive-brown on the sides of the body. The middorsal markings are black (occasionally very dark brown), and at least a large central area in each marking is solid black, with no invasion by the pale ground color. There is some variation, however; in many individuals the entire dark middorsal blotch is solid black, whereas in others the scales around the perimeter exhibit varying degrees of penetration by the paler ground color. The lateral markings are also black or very dark brown, but the posterior parts of the scales are invaded by the lateral ground color; in some the dark pigment predominates whereas in others it is greatly reduced. The ground color of the venter in adults varies through numerous tints of yellow. Ventral markings are usually present, and these range in coloration from gray or greenish gray to black. They tend to be clouded and more or less indistinct anteriorly, but they become darker and more conspicuous posteriorly, especially near and under the tail.

The coloration in the young is similar but usually paler. The middorsal dark areas are of a solid color, as among adults, but they may be dark gray or brown instead of black; the keels of the scales are somewhat paler. The lateral markings are invaded by the ground color, especially on the lowermost row of scales, but the young, in general, tend to be more conspicuously marked than adults from the same geographical regions. The midventral area in many live juveniles bears a longitudinal wash of orange or reddish orange.

The general coloration of an adult female (pl. 8, figs. 5 and 6), with a total length of 865 mm. (when photographed) from Playas, within 35 miles of Palenque, Chiapas, may be summarized as follows: Dorsal ground color Dark Olive in the middorsal area, but changing to a medium dull olive (Citrine-Drab) on the flanks of the body. Dorsal and lateral markings black, except where invaded by the ground color. Top of head Deep Olive; supralabials Dark Olive-Buff, the sutures between them Deep Olive to almost black on the posterior three; darker parts of the infralabials similar. Chin, throat, and remainder of infralabials dull yellow (Mustard Yellow), changing to paler yellow (Straw Yellow) for the first 25 ventrals, then to Olive-Buff and finally to Deep Olive-Buff. Center of venter with a finely stippled area of Buffy Brown that imparts the effect of a narrow, midventral, brownish stripe. Ventral markings consisting of black or very dark brown half moons, which are bordered by narrow areas of finely stippled brown. Under side of tail Pale Olive-Buff, with a stippled dark brown stripe along the common sutures of the subcaudals; markings black. Eye: Pupil black, with a faint rim of orange-yellow; iris Cinnamon-Brown. Tongue: Very dark gray, almost black, above and below, including tips.

The general coloration of a juvenile (pl. 8, figs. 3 and 4), with a total length of 345 mm., from Cosamaloapán, Veracruz, may be summarized as follows: Dorsal ground color Deep Olive in the middorsal area; dull olive (Citrine-Drab) on the flanks. Dorsal markings black; lateral markings with black on the anterior parts of each scale, the remainder invaded by the ground color. Top of head Deep Olive. Supralabials Deep Olive-Buff; sutures Deep Olive. Chin, throat, and infralabials very pale yellow (Marguerite Yellow). Belly pale yellowish buff (Colonial Buff) strongly washed with Cinnamon; ventral markings dark gray. Under side of tail Cinnamon-Buff, with black markings.

A large female (C.M. No. 38913) from 8 miles east-northeast of Tlacotalpán, Veracruz, is virtually unicolored, apparently because of the almost total absence of dark

pigment. The dorsum is pale olive-brown (khaki-colored) and is unmarked. There are a few dusky areas on the head, and the sutures between the labials, which are grayish brown, are but little darker than the pale yellow labial scales. The belly is plain yellowish, with small amounts of the dorsal coloration irregularly invading the lateral edges of the ventrals. A large male (M.M.N.H. No. 2119) from 1 mile north of Alvarado, Veracruz, closely matches the female described above, but it is badly mashed, and there are some dark areas on the anterior third of the dorsum that are probably the result of postmortem changes. Both snakes were found dead on the road, and these color notes are from the preserved specimens.

The dark middorsal blotches in *werleri* vary in number from 25 to 37, with a mean of 30.5.

Geographical Variation in Pattern

There is a marked tendency for specimens of *werleri* to be darkest toward the southern and far eastern portions of the range of the subspecies. Among snakes from Tabasco and Chiapas, the dark dorsal and lateral markings and diagonal lines are black. The ground color is also dark in comparison with that of snakes from farther north. The markings on the venter are usually in the form of half moons, and they are black, dark brown, or dark gray, and are usually most strongly evident in juveniles. They are also more numerous, extend much farther forward on the venter, and may even reach the neck region. In any case, however, the most anterior half moons are paler and not nearly so well defined as the posterior ones.

In contrast, among specimens from the delta of the Río Papaloapan and the perimeter of the Laguna de Alvarado the patterns are less prominent, particularly on the under surfaces. The middorsal blotches have centers of solid black or dark brown, a characteristic that is typical of *werleri* throughout its range, but the lateral markings are moderately to deeply invaded by the pale ground color. Ventrally, however, the dark markings are usually inconspicuous or even absent except under and near the tail.

The bulk of the specimens of *werleri* available for study are from the delta region of the Papaloapan, the vicinity of Coatzacoalcos, and scattered localities in Tabasco. When more material from numerous other and especially intermediate localities becomes available, it may be possible to determine whether there is a smooth or stepped cline involved in the difference of pattern intensity.

Size and Sex

The 10 largest females have measurements as follows: Head-body length, 1162 mm. (total length 1470+ mm.); 1153 mm. (1323+ mm.); 1141 mm. (1458 mm.); 1138 mm. (1432 mm.); 1125 mm. (1370+ mm.); 1066 mm. (1345 mm.); 1042 mm. (1180+ mm.); 984 mm. (1197+ mm.); 962 mm. (1230 mm.); and 956 mm. (1228 mm.). Comparable measurements for the 10 largest males are: 791 mm. (1010+ mm.); 759 mm. (927+ mm.); 710 mm. (958 mm.); 705 mm. (961 mm.); 692 mm. (944 mm.); 686 mm. (927 mm.); 666 mm. (922 mm.); 660 mm. (880+ mm.); 567 mm. (787 mm.); and 529 mm. (720 mm.).

Fourteen live young, apparently all full-term, were removed on July 20, 1962, from a female (T.C.W.C. No. 21937) collected two days previously in the delta of the Río Palaloapan about 11 miles southeast of Alvarado, Veracruz. These were measured by John R. Meyer in the field. One of the young was preserved (T.C.W.C. No. 19154), and the others were liberated. The total live length measurements varied from 273 mm. to 295 mm. (table 20). The preserved young specimen measures only 262 mm. in total length, indicating that some shrinkage may have taken place or, more likely, the live snakes were inadvertently stretched as they struggled to escape. A number of juveniles that were doubtless very young, and some of which may have been virtually newborn, were obtained in the field. These varied in total length from 272 mm. to 295 mm. Weights are available for only two small young. Data for these are as follows: (1) 1 mile north of Cosamaloapán, Veracruz, July 28, 1962, total length 350 mm., weight 13.4 grams; (2) 5 miles southwest of Coatzacoalcos, Veracruz, August 2, 1962, total length 346+ mm. (two or three scales missing from tip of tail), weight 10.8 grams. Data were recorded for both of these juveniles on

September 7, 1962; they each ate two small fishes between the time of their capture and their transportation to our home base.

Tail length/total length ratios of males of all sizes are 0.25 to 0.28, mean 0.268; for females, 0.21 to 0.26, mean 0.234.

Ecology and Natural History

Judged from the large numbers of *werleri* reported by several collectors, snakes of this taxon are abundant in many localities. Probably the distribution is virtually continuous through the enormous swamplands of southern Veracruz and Tabasco. Elsewhere it is largely restricted to streams, lakes, swamps, and their environs. It is surprising that Ruthven (1912) failed to find *Natrix* during his expedition to southern Veracruz, although at such an early date he obviously did not utilize the highly productive technique of road cruising at night by automobile.

The range of *werleri* falls within several of the zones of vegetation outlined by Leopold (MS). In Veracruz tropical evergreen forest prevails except for a small area of savanna chiefly inland from the Tuxtla Range and a strip of thorn forest near the coast that extends a short distance both north and south of the twentieth parallel of latitude. Virtually all Tabasco is covered by rain forest except for two small areas of savanna along the coast.

The rainfall, in Tabasco and portions of the adjacent states, is the heaviest in Mexico, with a mean annual precipitation varying from approximately 2500 mm. to 3500 mm. (Sanchez, 1936, map 11). Contreras Arias (1942), from whom the following climatological data were obtained, gave 3967 mm. as the annual rainfall at Teapa, 1919 mm. at Villahermosa, and 1463 mm. at Frontera, all in Tabasco, and characterized the climate at all three stations as hot and humid, with no winter season and no well-defined dry season. Conditions were similar at Coatzacoalcos, Veracruz, with 2884 mm. of rain. At the city of Veracruz the precipitation was 1623 mm., with a dry season from November to May. The entire area occupied by *werleri* is hot and humid, with the greatest amount of rainfall occurring in the southern and eastern portions of its range. Mean annual and maximum recorded temperatures (the latter in parentheses) listed for the several localities were: Coatzacoalcos, 25.0° C. (41.2° C.); Frontera, 25.7° C. (44.5° C.); Teapa, 25.0° C. (41.0° C.); Villahermosa, 26.0° C. (41.0° C.); and Veracruz, 24.8° C. (35.6° C.).

Smith (1943, p. 454) stated that "one specimen. . .was found in the Usumacinta River near the village pier at Emiliano Zapata (Montecristo), Tabasco." Although other specimens of *werleri* were also found in streams, lakes, and swamps, most of those collected were obtained on roads, chiefly at night. Roads that were especially productive are listed below, together with notes concerning their environs.

1. Veracruz: The coastal highway (Mexico No. 180) that follows the narrow arms of land separating the Laguna de Alvarado from the Gulf of Mexico. Large sand dunes are characteristic of this area both east and west of Paso Nacional, and among them are many fresh-water ponds and swales, some quite extensive, as at the type locality for *werleri*.

2. Veracruz: The road through the lowlands paralleling the Río Papaloapan from the vicinity of Ciudad Alemán to Tlacotalpán and beyond to the Laguna de Alvarado. Much of this region is swampy or subject to temporary inundation after heavy rains or when streams overflow. Some agriculture is practiced, and there are several towns on the higher ground.

3. Veracruz: The highway from Coatzacoalcos to the vicinity of Minatitlán (Mexico No. 180) that passes through a large *Typha-Pontederia-Thalia* marsh that extends most of the distance between the two cities (Conant, 1965a, fig. 4). Semiaquatic snakes of many other species were taken in the same marsh, some of them in large numbers. Included were *Coniophanes bipunctatus biseriatus*, *Coniophanes imperialis clavatus*, *Coniophanes quinquevittatus*, *Thamnophis proximus rutiloris*, and *Tretanorhinus nigroluteus lateralis*. The *Thamnophis* (ribbon snake) was also found associated with *N. r. werleri* in many other localities.

4. Tabasco: The highway (Mexico No. 180) extending northward from Villahermosa to Frontera. This road traverses large swampy areas and crosses a number of

streams. The open-water environment was increased during the construction of the highway by many shallow ponds that resulted after large quantities of earth were removed to form the roadbed, which rises many feet above the adjacent terrain in some areas. Many of the ponds, however, were changing, through ecological succession, to *Typha-Pontederia-Thalia* marsh (pl. 18, fig. 2), during our visits in 1962 and 1964.

5. Tabasco: The road extending southward from Villahermosa to Teapa that parallels the Río Teapa in part and passes through many swampy areas.

Undoubtedly many other roads of the general region would be equally productive. Almost all specimens that bear detailed collecting data were found during the early evening hours. Some snakes were on the roads directly adjacent to ponds or marshes; others were taken where semiaquatic habitats were not visible from the road, at least in the dark. The herpetofauna of the region is extraordinarily rich, but the "hit-and-run" tactics of most collectors, ourselves included, have resulted in the accumulation of only tantalizingly sparse information. The potentialities for a naturalist who could afford to reside in the area for a year or two are enormous. Some indication of the abundance of species was given by Smith (1960, pp. 222–223) in his report on material collected near Teapa, Tabasco.

Two large females of *werleri* (U.U. Nos. 3933, 3934), measuring 1163 mm. and 1026 mm. in total length, respectively, were found drowned in a turtle trap that had been set overnight along the Río San Augustín, at Tecolapia, 17 miles southeast of Alvarado (John M. Legler, personal communication). Legler was not certain whether the snakes entered the trap accidentally where it was set close to the bank of the river or whether they were attracted by fishes that had responded to the bait he was using for turtles.

Two young of *werleri* (M.M.N.H. Nos. 2452, 2453), measuring 320 mm. and 328 mm. in total length, were removed from the gullet of a common egret, *Casmerodius albus*, that was collected by R. W. Dickerman on the Río Culebra near Tlacotalpán, Veracruz. Young water snakes must frequently be eaten by a variety of avian predators, for semiaquatic birds of many species are abundant in the marshes, swamps, and waterways of Tabasco and southern Veracruz.

THE SUBSPECIES OF *NATRIX VALIDA*

Among the three species of *Natrix* indigenous to Mexico, *valida* is the only one confined to that country. Four subspecies are recognized, and they are characterized chiefly by pattern and coloration, but differences in scutellation are also useful in distinguishing between the races *isabelleae* and *valida* (chart 4).

The acquisition of a relatively enormous quantity of new material of the *valida* complex, much of which was studied alive, has required emendation of a few of the generalizations and conclusions previously published (Conant, 1946, 1953, and 1961). When the 1946 paper was written, no live snakes of any of the several subspecies had been seen, and only 31 preserved specimens were available from all of mainland Mexico. In any cases in which statements in the earlier papers are in disagreement with the ones included herein, those in the present paper should be accepted.

Distribution

This species is confined to western Mexico, where it ranges from southern Sonora to central Guerrero; an isolated subspecies occurs in the Cape Region of Baja California (map 4).

Among the three mainland races, the nominate form is widely distributed through the Pacific coastal plain southward from the Río Yaqui to the Marismas Nacionales in Nayarit. The subspecies *isabelleae* occurs from Jalisco to Guerrero in the short stretches of narrow coastal plain that are typical of the area, in the floodplains at the mouths of rivers flowing into the Pacific, and in the

attenuated lagoons paralleling the coast, but it also ascends at least some of the rivers for considerable distances. An upland race, *thamnophisoides*, occupies an outlier of the *altiplano* in the vicinity of Tepic, Nayarit, and the isolated *celaeno* occurs in at least the foothills of the mountains of extreme southern Baja California and in the intermittent streams that flow from the mountains to the sea. Three-way intergradation among the subspecies *valida*, *isabelleae*, and *thamnophisoides* occurs from the vicinity of Rosamorada, Nayarit, southward to Puerto Vallarta, Jalisco.

The collective vertical range of the four taxa is from sea level to at least 1200 meters (3937 feet).

In the arid northern portion of its range, *valida* is restricted to the rivers, each of which supports a tenuous and often intermittent gallery forest across the coastal plain. Until recently these rivers were isolated from one another, but irrigation projects now make it possible, theoretically at least, for water snakes to move from one river system to another (p. 126). Presumably, during pluvial periods in the past, this species was widespread along the west coast of Mexico, and it may also have occurred throughout much of the Baja California peninsula and around the head of the Gulf of California. (See discussion on the distribution of the subspecies *celaeno* on p. 118.)

Within their respective ranges all four forms probably occur in virtually every permanent body of fresh water of sufficient magnitude to furnish both food (principally small fishes, frogs, and toads) and shelter. There is evidence that these snakes may occasionally (seasonally?) enter brackish water along the coast. Recent collecting has demonstrated that all four are locally abundant and that *Natrix valida* is not the rarity it once appeared to be.

Most specimens of *valida* from the Cape Region of Baja California are melanistic, and melanism is also of frequent occurrence in snakes on the mainland at approximately the same latitude (see pp. 94, 95). The parallel is heightened by a likening of the coastal plain in Sonora, Sinaloa, and Nayarit to a long, southward projecting "peninsula" that widens in the region of the Marismas Nacionales near its southern terminus south of San Blas (map 5). Melanism, which elsewhere throughout the range of the *valida* complex is rare and confined chiefly to the cephalic and ventral parts of the body, is strong at the southern tip of the mainland "peninsula" as well as at the southern extremity of the true peninsula of Baja California. Comment on this phenomenon was

CHART 4

DIAGNOSTIC CHARACTERISTICS OF THE FOUR SUBSPECIES OF *Natrix valida*

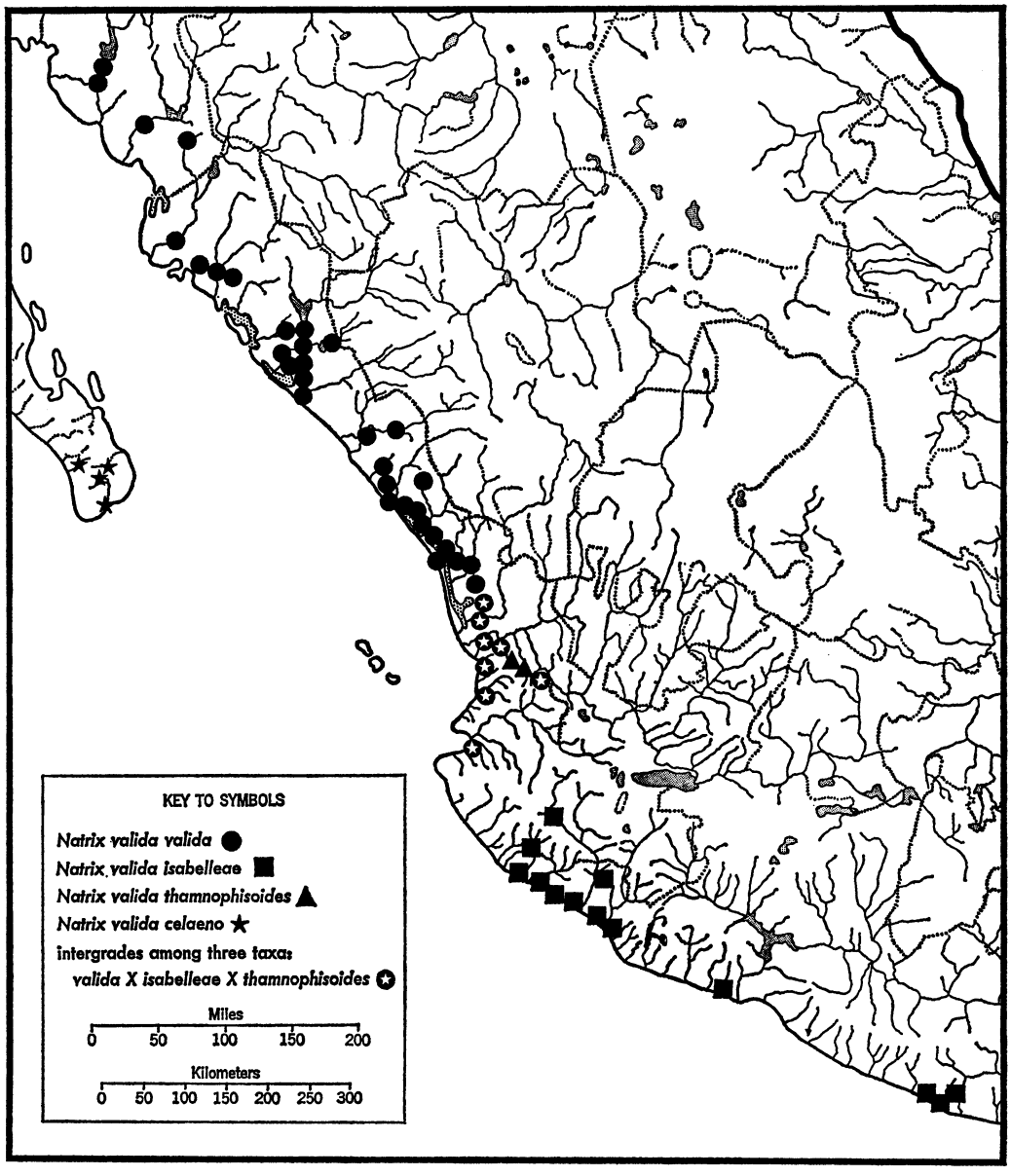
Characteristics	*valida*	*isabelleae*	*thamnophisoides*	*celaeno*
Pale longitudinal stripes	None	Lateral; on first 2 or 3 rows of scales	Middorsal and often also lateral on first 2 or 3 rows of scales	Lateral with ragged edges and involving first to third rows of scales[a]
Dorsal coloration	Brown or gray; seldom dark brown	Often dark brown or chocolate brown	Brown or brownish olive	Black or very dark brown[a]
Dark dorsal spots in one row (males and females combined)	53–82, mean 70.0	63–73, mean 66.9	63–78, mean 71.5	75–97, mean 86.7[b]
Ventrals minus subcaudals				
Males	53–74, mean 63.8	52–58, mean 55.4	52–68, mean 61.0	57–70, mean 64.5
Females	60–78, mean 69.9	57–65, mean 61.5	54–69, mean 64.5	63–77, mean 70.3

[a] Many specimens of *celaeno* are indistinguishable in coloration and pattern from those of mainland *valida*.
[b] Spots countable only in specimens resembling those of mainland *valida*.

made in a previous paper (Conant, 1961, p. 10).

Size and Proportions

Snakes of this complex are smaller and more slender than members of either of the other two species of *Natrix* (*erythrogaster* and *rhombifera*) in Mexico. Females attain a greater length and girth than males, but only a single female, among the hundreds of members of the *valida* complex studied, has both a complete tail and a total length in excess of 1 meter; it belongs to the subspecies *valida* and measures 1068 mm. Another female, with an incomplete tail, however, had a presumed total length of 1136 mm., calculated from the means of ratios for the largest specimens of the same sex and taxon (table 11). The presumed maximum total lengths of the largest females of the other



Map 4. Stream map showing locality records for the subspecies of *Natrix valida*.

three races, all of which also have incomplete tails, average well in excess of 900 mm. (table 11). Males from mainland Mexico are considerably smaller than mainland females, but males of *celaeno* attain a greater size than males of any other race, and the largest are comparable with females of the same subspecies. In *celaeno* the largest male measures 955 mm. in total length in comparison with 963 mm. for the (presumed) total length of the largest female. The six largest males of *celaeno* exceed the largest male of any other race, which is of the subspecies *valida* and has a total length of 774 mm. The larger dimensions of the males of *celaeno* are probably not an accident of sampling, inasmuch as large series of all four races are available for study. The greater girth in females is only partially associated with higher dorsal scale counts, for, except in the subspecies *celaeno*, only a relatively few females have more scale rows than males.

The head is distinct from the neck and is relatively broad in fully mature adults, especially females. The width of the eye is usually less than its distance from the nostril, but in many individuals, chiefly juveniles, the two dimensions are approximately equal.

The body is rounded in cross section. The tail is moderately long and attains a greater proportionate length in males than it does in females.

Juveniles are more slender, proportionally much more so, than juveniles of the other species of *Natrix* in Mexico. Newborn young vary from 165 mm. to 223 mm. in total length (table 21).

Scutellation

The dorsal scales are strongly keeled, with the exception of most of those of the lowermost row. In that row there is a progressive increase in development of the keels in a posterior direction; scales in the neck region lack keels entirely, at midbody they are weakly keeled, and anterior to the anal region they are as strongly keeled as the scales of the rows immediately above them. The keels in the anal region are weakly knobbed in males. Paired apical pits are present on at least a few scales in many specimens of each of the mainland races, at least in the nuchal region, but they normally are absent or difficult to find. I have not detected apical pits in any of the fresh material I collected in Baja California, but it is possible that pits do occur sparingly in populations of *celaeno*. There is much individual variation in the presence or absence of pits, as I pointed out previously (Conant, 1961, pp. 5, 18). The maximum number of scale rows is most frequently 19, but counts of 21 occur in some mainland specimens and among half of the females of *celaeno*. The minimum number is almost invariably 17. The anal plate is divided in all specimens, with one exception; it is single in an adult female of *thamnophisoides*.

The numbers of ventral and subcaudal scales is useful in distinguishing among some of the taxa, and the differences are best demonstrated when the subcaudals are subtracted from the ventrals (fig. 2).

Dentition

The following summary is based on tooth counts made on 22 specimens of the *valida* complex, of which 10 are from Baja California and 12 from mainland Mexico. The number of counts involved in each case is indicated in parentheses. Complete counts could not be made in some instances because of damage to the dentigerous bones; in one case the anterior tip of the dentary was missing.

Maxillary teeth: 23 to 27, mean 25.2 (42)
Palatine teeth: 12 to 15, mean 13.8 (41)
Pterygoid teeth: 23 to 31, mean 26.5 (42)
Dentary teeth: 25 to 30, mean 27.5 (41)

When a comparison is made between the peninsular and mainland samples, the counts are higher in the sample from Baja California in every category, as is evident from an examination of the following means (those for mainland Mexico appear in parentheses): maxillary, 25.6 (24.9); palatine, 14.1 (13.6); pterygoid, 27.2 (26.0); and dentary, 28.2 (26.8).

Coloration and Pattern

The basic pattern in all races of *valida* consists of four rows of small black or dark brown spots on a ground color of gray or brown, but there are many individual variations. The dark spots in most specimens appear on the scales of the fourth or fifth

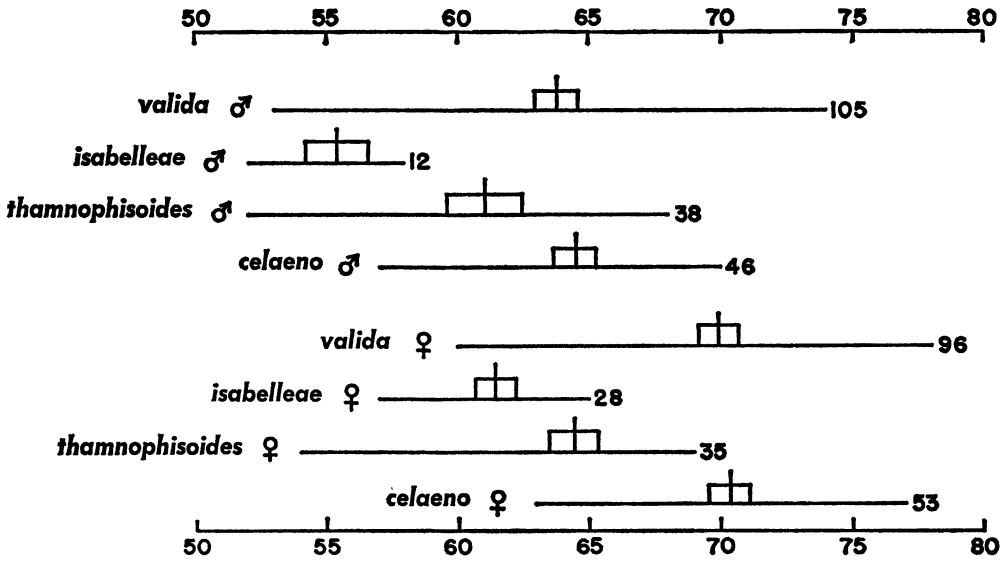


FIG. 2. Ventral scales minus subcaudal scales among the subspecies of *Natrix valida*. The horizontal bar indicates the range of variation in each sample; the vertical bar, the mean; and the rectangle, two standard errors of the mean on each side of the mean. The number of specimens comprising each sample is indicated at the right side of each individual graph.

and the seventh and eighth rows of scales, but similar, although usually smaller, spots may occur on virtually any of the dorsal scales. They are usually most conspicuous in the middorsal region and on the anterior part of the body.

The dark spots normally consist of a dark V on the anterior corners of individual scales. The size of the spots varies, and some individuals have relatively large ones, but these normally result from the presence of dark pigment on the edges of several closely adjacent scales. In virtually all cases the centers of the scales are pale and match the general dorsal ground color. Counts of the number of dark spots in a single row (from immediately posterior to the head to a point directly above the anal opening) could be made on only a limited number of specimens. In many snakes they are faint, virtually obsolete, or lacking either anteriorly or posteriorly, or both, so that the series is incomplete. Also there are many irregularities —spots may run together, for example. All spot counts summarized in the discussions of the several subspecies should be considered as approximations. The counts were made on the lower row on the convex side of the body. The coiling of the specimens to fit into bottles tended to separate the scales slightly on that side, so the spots showed more clearly. Spots were not counted on melanistic specimens.

Pale stripes are present in two of the mainland races, a middorsal one in *thamnophisoides* and lateral ones in *isabelleae*. Among individuals of all four subspecies dark spots are absent or only sparsely indicated on the lowermost two or three rows of scales.

Many specimens from the Cape Region of Baja California are indistinguishable from specimens of the subspecies *valida*, but the bulk of the material of the subspecies *celaeno* is melanistic, with black or very dark brown pigment predominating, except on the sides of the body where a gray or olive stripe with irregular edges is situated on the first three rows of scales. Snakes exhibiting various degrees of melanism are also found on the mainland in Nayarit in the area where intergradation occurs among three taxa—*valida*, *isabelleae*, and *thamnophisoides*.

Juveniles resemble adults, and there apparently are no marked ontogenetic changes

in any of the several races, even among the dark populations of *celaeno*. In the latter, very small juveniles are melanistic and closely resemble adults from the same areas.

Hemipenis

The everted hemipenis may be described as follows: Shaft subcylindrical and thickly covered with small spinules that diminish in size and extend distally to involve the entire outer surfaces of the two lobes; nude patches at the base adjacent to the basal and accessory hooks. Apex bilobed and nude throughout the entire surface within the crotch. Sulcus simple and terminating in the depression between the lobes. One large basal hook (the free edge 2 mm. to 3 mm. long in snakes measuring 500 mm. to 850 mm. in total length) lateral to the sulcus and followed distally by a smaller hook, and with two spines in close proximity. An accessory hook on the opposite side of the sulcus, slightly more distal and somewhat smaller than the large basal hook.

In situ the hemipenis extends caudally to the ninth to twelfth subcaudal, and the M. retractor penis magnus originates on the caudal vertebrae at the level of the twenty-third to the twenty-eighth subcaudal.

Geographical Variation

Several pattern variations are discussed above. Geographical differences in scutellation include a reduction in the number of ventrals in the two southern mainland races (*isabelleae* and *thamnophisoides*) in comparison with the northern one (*valida*), and an increase in the maximum number of scale rows in the isolated *celaeno*. Among the mainland races the maximum number of dorsal scale rows normally is 19 in both sexes, but counts of 21 occasionally occur but only slightly more frequently among females than among males. In *celaeno*, of Baja California, however, counts in excess of 19 (usually 21) occur in 16 per cent of all males and in 55 per cent of all females. Males of *celaeno* attain a considerably greater size than mainland males, and in both sexes of *celaeno* the number of dark spots in any one row on the body is greater than the number in any of the mainland races (table 14).

Natrix valida valida (Kennicott)

Mexican West Coast Water Snake

Plate 9, figures 1–3

Regina valida Kennicott, 1860, p. 334.

Tropidonotus quadriserialis Fischer, 1879, p. 78.

Natrix valida valida: Cope, 1892, p. 670.

Type and Type Locality

U.S.N.M. No. 1309, holotype, an adult female. The type locality, stated to be "Durango," cannot be pinpointed and should be considered as unknown. It may have been along the trail leading from Ventanas (=Villa Corona) in the low tropical portion of the barranca of the Río del Presidio or even on the coastal plain of Sinaloa (see discussion below). The type is badly faded and almost unicolored, but it agrees in scutellation with Kennicott's (1860, p. 334) description. Despite the lack of pattern there is no question about assigning the type to the subspecies *valida* as defined and recognized in the present paper. Kennicott made no mention of longitudinal stripes such as occur in the subspecies *thamnophisoides* and *isabelleae*. The number of ventrals is 138, which is well within the range of variation in *valida* but equal to the highest count for *isabelleae*. The subcaudals are 66, and, when they are subtracted from the number of ventrals, the resulting figure is 72, which is near the mean for *valida* (fig. 2) but considerably higher than the highest known for *isabelleae*. I reexamined the type on January 7, 1960, and counted the ventrals in accordance with the Dowling (1951b) system, and I recorded the subcaudals as 66 rather than 65. Otherwise the scutellation agrees with the information published in my first paper on the *Natrix valida* complex (Conant, 1946, p. 254).

Comments on Type Locality

Kennicott (1860, p. 335) recorded the type locality and collector as "Durango, Mexico, Lieut. Couch," but the original catalogue entry at the United States National Museum reads "1309—*Nerodia Regina valida*, Durango, Mex., Dr. Webb." Two later workers, Yarrow (1882, p. 132) and Cope (1900, p. 986), both ascribed this specimen to "Dr. Thos. Webb."

Who collected the animal, Couch or Webb, and did it actually come from Durango?

Such evidence as can be marshaled at this late date, and much of it negative, suggests that the type of *Natrix valida* was collected by neither Couch nor Webb, and it is questionable whether the type locality was within the borders of the state of Durango. At least it was not at the capital city (Victoria de Durango) as some authors have inferred.

It is instructive to examine the routes taken across Mexico by Webb and Couch during their expeditions.

Thomas H. Webb, in his capacity as secretary and surgeon to John Russell Bartlett's party of the United States and Mexico Boundary Commission, made two excursions into Mexico. The first (Goetzmann, 1965, pp. 180–181) began on August 27, 1851, south of the Gila River in Arizona and proceeded to Santa Cruz, Magdalena, and Ures, the last on the Río Sonora northeast of Hermosillo, Sonora. From there Webb returned northward, whereas Bartlett journeyed south to Mazatlán and Acapulco. Webb's second trip through Mexico (in 1852) was reviewed by Kellogg (1932, p. 4). The party traveled from Tucson to El Paso through northern parts of Sonora and Chihuahua, and from El Paso southward to the city of Chihuahua, to Quincamé (= Cuencamé), Durango, and then eastward to Saltillo and Monterrey, and from there to the Ringgold Barracks at the present town of Rio Grande City, Starr County, Texas.

In contrast, Darius Nash Couch's route was poorly known, a fact that prompted me to reconstruct it in considerable detail (Conant, 1968). Couch entered Mexico at Matamoros on the east coast and traveled west to Monterrey, Saltillo, and Parras and to the Río Nazas in extreme eastern Durango, and he returned by much the same path.

It is obvious from a study of the routes of the two men that neither visited the city of Durango. Both penetrated the state of Durango only in its very arid eastern portions—Webb across the northeastern corner and Couch in the Bolsón de Mapimí.

Natrix valida is scarcely to be expected in the Chihuahuan Desert. It is essentially a lowland animal of the Pacific coastal plain and adjacent valleys, and the lower portions of the streams issuing from the western and southern versant of the Sierra Madre Occidental (map 4). If it occurs in Durango at all, it would most likely be at low elevations close to the border of Sinaloa. Data derived from other specimens suggest that there has been a multiplicity of errors and that the type locality for *Natrix valida* may never be known.

I have found several other references to animals from Durango credited to Webb. These, with comments upon them, are as follows: a kangaroo rat, *Dipodomys ordii* (Baird, 1857, p. 412); a garter snake, *Eutaenia* (= *Thamnophis*) *cyrtopsis* (Yarrow, 1882, p. 121); two blind snakes, *Rena* (= *Leptotyphlops*) *dulcis* (U.S.N.M. Nos. 2085, 2086); a gecko (U.S.N.M. No. 3208), *Phyllodactylus tuberculosus* (Baird, 1859, p. 12); an iguanid, *Anolius* [*sic*] (U.S.N.M. No. 3210); and a frog, *Smilisca lateralis* (U.S.N.M. No. 3259). Among these, all the herpetological specimens, although originally catalogued at the United States National Museum, are no longer in the collection (James A. Peters, personal communication), with the exception of the garter snake.

There is no problem involved with the kangaroo rat, for the species occurs throughout the portion of Durango traversed by Webb (map in Hall and Kelson, 1959, p. 515), or with the specimens of *Leptotyphlops dulcis*, which are of a species that is known from the Chihuahuan Desert in Coahuila (Klauber, 1940, map 1) and probably also occurs in Durango along Webb's route. Both of these may have been correctly ascribed to Webb. The individual of *Smilisca* is unidentifiable by name, according to William E. Duellman (personal communication), an authority on hylids who recently co-authored a review of the genus (Duellman and Trueb, 1966).

The other specimens, however, require discussion. Webb could not have personally collected the specimen of *Anolis* in Durango, for, according to data supplied by Hobart M. Smith (personal communication), *Anolis nebulosus*, the sole member of the genus recorded from Durango, is known only from the western barrancas and the highlands near the southern end of that state. Webb did not visit those parts of Durango.

The gecko, *Phyllodactylus*, which appears to be absent from the plateau in Durango, and the garter snake, *Thamnophis*, which fortunately is still extant and which can be demonstrated to represent a lowland taxon, present special problems.

Dixon (1964, p. 35), in his review of the genus *Phyllodactylus* in North and Central America, listed three localities for *P. tuberculosus* from Durango. One, stated simply as "Durango," was taken from the literature and presumably was based on the now missing U.S.N.M. No. 3208; the other two, for which museum numbers are cited and which apparently were examined by Dixon, were from Taylotita and Ventanus, misspellings or variant spellings, respectively, for Tayoltita and Ventanas. Only the first two of these were plotted by Dixon (map 2, p. 124), who thus placed one of his symbols on the city of Durango. He evidently was unable to find Ventanas, which, according to Zweifel (1956b, p. 22), appears on recent maps as Villa Corona and is at an elevation of 620 meters (2034 feet) in the barranca of the Río del Presidio. Tayoltita, situated on the Río Piaxtla at an elevation of 570 meters (1870 feet), is barely within the border of Durango. (Robert G. Webb and Baker, 1962, p. 333, suggested the possibility that this gecko also occurs in a barranca of the Río de Acaponeta drainage south of Pueblo Nuevo in southwestern Durango.)

Dixon's map (*loc. cit.*) indicates that *Phyllodactylus tuberculosus*, from southern Sonora to the northern extension of Jalisco, is confined to the lowlands and barranca country of the region, with the sole exception of "Durango." There is no evidence, however, for its occurrence at the city of Durango or elsewhere in the uplands or on the plateau in the state of Durango.

Dixon (personal communication) states that the illustrations of *Phyllodactylus tuberculosus* in Baird's "Reptiles of the boundary" (1859, pl. 23, figs. 1–8), which were delineated from the missing U.S.N.M. No. 3208, are too schematic for positive identification. He thinks that they may represent "*P. tuberculosus saxatilis* from the foothills of the Pacific coast."

The specimen of *Thamnophis cyrtopsis* ascribed to Webb is still in the United States National Museum collection (U.S.N.M. No. 8066) and is in relatively good condition. Its middorsal light stripe terminates five or six scales posterior to the parietal scutes, so that the dark nuchal collar is complete. There is no continuous dark stripe along the first row of scales; instead, there are small discrete black spots on the first row (first and second rows near the head). There are two rows of alternating black spots between the longitudinal light dorsal stripes on both sides of the body. All these pattern elements are characteristic of *T. c. collaris*, a form that occurs widely through the lowlands of western Mexico but that in Durango "is known only from the deep barrancas that dissect the Sierra Madre, and from the highest subtropical parts of the west-facing slopes; presumably USNM 8066 came from one of those two areas" (Robert G. Webb, 1966, pp. 60–61).

Comment should be made on the fact that I examined the specimen of *Thamnophis* in question at the United States National Museum on January 27, 1965, and found that it, as is the type of *Natrix valida*, is credited both to Webb (on a paper tag accompanying the specimen) and to "D. N. Couch" (in the card catalogue, although in the latter case the notation is accompanied by the word "probably"). The herpetological catalogue at the United States National Museum gives no collector's name, but Kennicott, in his original description of *Eutaenia cyrtopsis* (1860, p. 334), ascribed the Durango specimen to "Lieut. Couch."

A century ago the west coast of Mexico was accessible only by sea or the few mountain trails that descended from the *altiplano* to the lowlands. One of the trails followed the pack-train route described and mapped by Farrington (1904, pp. 199–208, pl. 54) from the city of Durango westward through the mountains to La Ciudad de Rocas and Ventanas (=Villa Corona), and which continued onward to Mazatlán on the Pacific coast. The approximate routes of this trail and another one descending by way of (Santiago) Papasquiaro and Reyes appear on an early map of Mexico (Disturnell, 1853). It is possible that the garter snake (U.S.N.M. No. 8066) was collected at a low elevation along one of these trails. It quite evidently

did not come from the city of Durango or any other place in the highlands where the subspecies *cyrtopsis* or *pulchrilatus* would be expected.

Evidence that collecting localities along the Ciudad-Ventanas trail have long been confused may be found in Boulenger (1885, pp. 196, 215, 233) and Günther (1890 [1885–1902], pp. 57, 62, 72), if records they listed are compared with our present knowledge of distributions of three lizards of the region. For *Ctenosaura acanthura* (= *C. pectinata*) both of these authors included Mazatlán, Presidio, Ciudad, and Ventanas; for *Uta bicarinata* (= *Urosaurus bicarinatus*), Presidio, Ventanas, and Ciudad; and for *Sceloporus microlepidotus* (= *S. grammicus*), Ciudad and Ventanas. All are credited to A. Forrer. According to Robert G. Webb, who is studying the herpetofauna of Durango and who called my attention to these discrepancies, the lowland species of *Ctenosaura* and *Urosaurus* do not occur at Ciudad, where the elevation is about 8000 feet (2438 meters) and the habitat consists of pine-oak forest. Contrariwise it is improbable that *Sceloporus grammicus*, an abundant animal of the high forests, is found in the lower portion of the barranca at or near Ventanas. Robert G. Webb (1966, p. 61) found similar discrepancies among localities for *Thamnophis cyrtopsis*. It is also possible that the specimen of *Anolis* supposed to have been collected by (Thomas) Webb came from the same region. Boulenger (1885, p. 77) and Günther (1885 [1885–1902], p. 49) both credit Forrer with having collected *Anolis nebulosus* at Ventanas. Obviously there has been a mixup of data along this trail.

It is likely that the specimens of *Natrix valida*, *Phyllodactylus tuberculosus*, and *Thamnophis cyrtopsis*, and perhaps of *Anolis*, were all carried upward along the same route by one or more persons. The "Durango" locality may be correct for all, but, if so, it should be qualified as extreme western Durango in or near the lower parts of the *vertientes*. If one or more of them actually came from the present state of Sinaloa, which is a distinct possibility, then one of several errors may have occurred: (1) there was confusion concerning the exact boundary between the states; (2) "Durango" indicated the general region through which the collector was traveling; or (3) it represented the shipping point rather than the collecting station. In any event it is improbable that any one of them was caught at or near the city of Durango. How these animals happened to be ascribed to Webb or Couch cannot be settled at this time, but obviously there have been errors in recording the data for these reptiles.

Another possibility that must be examined is whether *Natrix valida*, *Phyllodactylus tuberculosus*, and perhaps other lowland organisms might have achieved the high plateau by working their way headward through the valley of the Río Mezquital, the river that drains the basin where the city of Durango is situated and becomes the Río San Pedro in the downstream portion of its course. Meek (1904, p. xxxvii), in his list of 11 species of fishes from the Río Mezquital system, stated that only three, *Characodon garmani*, *Characodon furcidens*, and *Chirostoma mezquital*, "can properly be ascribed to the southern or tropical fauna." Meek also stated that, among these, *Characodon furcidens* was known only from near the mouth of the river.

Albritton, in a paper on the stratigraphy of the Guadiana Valley, east of the city of Durango (1958, p. 1213), apparently misinterpreted Meek's statements, for he wrote that "at least two species of tropical fish have migrated from the Pacific lowland into the Guadiana Valley up the Mezquital and Tunal Rivers." Albritton further stated that "the deadly scorpion of Durango is also a tropical migrant that followed the valley of the Mezquital upward from the coast of Nayarit (Rouaix, 1929, p. 27–28)."

In response to an inquiry regarding the known distributions of the 11 species of fishes listed by Meek (*loc. cit.*), Robert Rush Miller (personal communication) advises me that none lives lower in the Mezquital than the Durango area and that "no fishes have ascended the Mezquital from the coastal plain." Hubbs (1932, p. 68) showed that Meek's "record" for *Characodon furcidens* from the mouth of the Mezquital-San Pedro system was probably based on a specimen taken in another drainage system farther south.

Regarding the scorpion, Willis J. Gertsch

(personal communication) believes that "garbled systematics" are probably responsible for the assumption that the *alacrán* may have migrated headward through the valley of the Río Mezquital. Actually two species are involved, as indicated by the distribution map of the Mexican forms of *Centruroides* published by Hoffman (1939, p. 327). *Centruroides suffusus* occurs on the plateau in Durango and along its common border with Sinaloa, whereas *C. noxius* is almost exclusively confined to Nayarit. Hoffman's map suggests that the two species may be sympatric at or near a point along the Mezquital where their ranges meet. Rouaix (1929, pp. 31–32) made no attempt to present a complete list of the fauna of the region, and he doubtless was unaware that two quite distinct species of scorpions were involved instead of one that, as he thought, occupied both the lowlands and the plateau.

Since no fishes have climbed the escarpment of the Sierra Madre Occidental along the Río Mezquital, it is also unlikely that the semiaquatic *Natrix valida* has succeeded in doing so. At least there is no evidence to support such a supposition. Some indication of the flooding and scouring to which the Mezquital and its tributaries are subjected in their rapid descent during the rainy season was observed in two streams near Nombre de Dios, Durango, that we visited on July 19 and July 20, 1959. These were labeled the Río Coapanco and the Río Melones along the highway (Mexico No. 45), although the latter is the main stream of the Mezquital. The swift-flowing Río Melones passed through a gorge at that elevation (*circa* 1730 meters or 5676 feet), and water-borne debris was lodged 15 feet and more above our heads in the branches of huge cypress trees. Farther downstream the gradient is much steeper and the descending water must travel with great force and speed. Any aquatic or semiaquatic animal populations working headward during the dry season and establishing themselves upstream would be subjected to marked attrition or even extermination during periods of rapid runoff.

To complete the roster of negative evidence, we searched briefly but unsuccessfully for *Natrix valida* in the vicinity of Durango, especially along the Río del Tunal and Río Santiago east of the city, during 1959, 1960, and 1962. Several other collectors who have worked in the area recently also failed to find the water snake there.

Finally, mention should be made of the remote possibility that the type of *valida* may have been obtained during the trip that Webb and Bartlett made into Mexico during 1851. Although there is no evidence at hand even to suggest it, *valida* may occur (may have occurred?) in the Río Sonora at Ures where Webb attended Bartlett while the latter was suffering from typhoid fever (Goetzmann, 1965, p. 180). Bartlett later traveled through the range of *valida* on his way south and may have obtained the type somewhere along the route, although without the stimulus of Webb's presence it seems unlikely that he would have preserved the specimen and carried it with him.

Because it is impossible to pinpoint where and by whom the type of *Natrix valida* was collected and whereas there is no evidence to indicate that this species has achieved the plateau in the Durango basin by ascending the Río Mezquital, I recommend that the type locality be regarded as unknown unless other information comes to light.

Range

The Río Yaqui, in southern Sonora, southward to the vicinities of Rosamorada and San Blas, in Nayarit, where the populations show evidence of the influence of other subspecies, and many individuals have considerable dark pigmentation on the dorsal or ventral surfaces, or both (see pp. 94, 95, map 4). This taxon is apparently confined to the Pacific coastal plain, the adjacent foothill areas, and probably the lower portions of the great barrancas associated with the Sierra Madre Occidental. There is as yet no evidence that *valida* is indigenous to any of the streams traversing the desert northwest of the Río Yaqui, although it may occur in the Río Sonora. Bogert and Oliver (1945, p. 414), at a time when *valida* was unknown northwest of Culiacán, correctly postulated that it might be found in the Río Mayo and the Río Fuerte. The species was first collected in the Río Mayo in 1956 and in both the Río Fuerte and the Río Yaqui in 1959.

Most records (map 4) are from along the

main coastal highway (Mexico No. 15) or secondary roads leading from it to coastal or estuarine communities, and they reflect the dependence on the automobile in present-day field operations. Records from east of the highway are few and collectively constitute only a fragmentary indication of the eastern and higher limits of the range. Exploration eastward along some of the streams either on foot or with the use of pack trains would yield valuable information on the distribution of *valida* and, indeed, on the fauna and flora in general. Unfortunately, most collectors, with limited time at their disposal, ourselves included, have been forced merely to sample the herpetofauna by stopping at streams and other likely habitats.

In Sonora in the arid northwest and through much of the thorn-forest region of Sinaloa, the range of *valida* is discontinuous, and there are disjunct populations in each of the river systems, although recently constructed impoundments and irrigation canals now make it possible, in some instances, for water snakes and other semiaquatic and aquatic organisms theoretically to move from one drainage system to another (see p. 126). Conversely, the range is probably virtually continuous, at least during the rainy season, throughout the Marismas Nacionales of southern Sinaloa and adjacent Nayarit, and the associated complex delta systems from the Río del Presidio southward to the vicinity of San Blas, Nayarit (see p. 98).

Altitudinal records vary from sea level to about 600 feet (183 meters) near Alamos, Sonora, and about 800 feet (244 meters) in Río de Baluarte drainage 5 miles southwest of Copala, Sinaloa. In all probability *valida* ascends considerably higher in at least the lower portions of some of the barrancas of the western escarpment of the Sierra Madre Occidental.

The locality data and museum numbers for the 267 specimens studied in detail are as follows:

DURANGO: Locality not stated (U.S.N.M. No. 1309); this snake is not from the city of Durango and may not even be from the state (see discussion regarding type locality, pp. 83–87).

NAYARIT: Acaponeta, along the Río de Acaponeta (A.M.N.H. Nos. 62278, 62283–62296); 5.2 miles south-southeast of Acaponeta (A.M.N.H. No. 90130); 8.5 and 9.8 miles south-southeast of Acaponeta (L.B.S.C. Nos. 600710-8, 600710-24); 8.6 miles south-southeast of Acaponeta (U.I.M.N.H. No. 6392); 4.3 to 4.6 miles west of Acaponeta (L.B.S.C. Nos. 600710-14, 600710-15); 4.9 to 6.3 miles south (on Highway No. 15) of the Acaponeta turnoff (L.A.C.M. Nos. 7133, 7134, 7136–7139); 12.3 miles south of the Acaponeta turnoff (L.A.C.M. No. 7135).

SINALOA: Camino Real de Piaxtla (A.M.N.H. Nos. 69682, 69683); 1 mile southeast of Camino Real on the Río Piaxtla (K.U. Nos. 63737, 63788); Chupaderos on the Río Chupaderos, 5 miles southwest of Copala (A.M.N.H. No. 94805; M.S.U. Nos. 3162–3166, 4170; U.M.M.Z. No. 102287); 8 miles north of Concordia (L.A.C.M. No. 7129); 2 miles east of Costa Rica (K.U. Nos. 93495, 93496); 0.4 mile to 2.2 miles west of Costa Rica (S.U. Nos. 23982, 23983); Culiacán in the Río Culiacán (A.M.N.H. Nos. 62279, 62280, 75190, 80083); 11.8 miles north of Culiacán (L.A.C.M. No. 7131); 11 miles northwest of Culiacán (A.M.N.H. No. 88885); 18.5 miles east of Culiacán in the Arroyo Sonalona (U.M.M.Z. Nos. 113077, 113078); Eldorado (U.I.M.N.H. Nos. 46972, 46973); within a 7-kilometer radius of Eldorado (A.M.N.H. Nos. 90739–90750); 7.8 miles north of Eldorado (S.U. Nos. 24010, 24099–24108); 10.2 to 21.5 miles north of Eldorado (S.U. Nos. 23984–23994); 21.7 to 33.1 miles north of Eldorado (S.U. Nos. 23972–23981); Escuinapa (T.C.W.C. No. 20811); 1 mile northwest of Escuinapa (L.A.C.M. No. 7130); 1 mile south of Escuinapa (L.A.C.M. Nos. 7148, 7149); 14 and 14.4 miles southeast of Escuinapa (C.A.S. Nos. 95800, 95801); 15.5 miles southeast of Escuinapa (S.U. No. 24003); 13 miles northwest of Guamúchil (L.A.C.M. No. 7122); La Concha (L.A.C.M. No. 7132); 21 miles southeast of Los Mochis (U.S.N.M. No. 151783); Mazatlán (F.M.N.H. No. 115619; I.B.U.N. not numbered; K.U. No. 63427; M.V.Z. No. 66208; U.I.M.N.H. No. 18658); northern edge of Mazatlán to 2 miles north of the city limits (A.M.N.H. Nos. 19390, 85354, 85355, 87578; A.N.S.P. Nos. 27242, 27243; C.A.S. No. 94287; I.N.H.S. No. 9772;

L.A.C.M. No. 7125; S.U. No. 23995; U.A.Z. No. 14482; U.F. Nos. 12814, 16545; U.M.M.Z. Nos. 114639, 114640); near Mazatlán airport (C.A.S. No. 89708; L.A.C.M. Nos. 7144–7146); 3.3 miles north of Mazatlán (U.A.Z. No. 14481); 6.6 miles north of Mazatlán (U.I.M.N.H. No. 81142); 16 miles north of Mazatlán (A.M.N.H. No. 85356); 19.9 miles north of Mazatlán (L.A.C.M. No. 7123); 22.5 miles north of Mazatlán (A.M.-N.H. No. 85357); 15 miles east of Mazatlán (U.I.M.N.H. No. 81562); 12.3 and 14.2 miles east of Navolato (S.U. Nos. 23966, 23967); 4.8 miles southeast of Navolato (S.U. No. 23968); 10.2 to 10.8 miles southeast of Navolato (S.U. Nos. 23969–23971); near Presidio, about 15 miles east-southeast of Mazatlán[1] (F.M.N.H. No. 115620; U.I.-M.N.H. No. 18657); 3.4 and 5.2 miles north of Río Cañas (S.U. Nos. 24004, 24005); Río Fuerte north of Los Mochis (A.M.N.H. Nos. 84078, 84079); Río Piaxtla, 2 miles north of Ixpalino (A.M.N.H. Nos. 88886–88892); Río Piaxtla at San Ignacio (L.A.C.M. Nos. 7126–7128); Río Presidio, 0.5 mile north of Villa Union (T.C.W.C. Nos. 24197–24231); Río Quelite near Quelite (A.M.N.H. Nos. 87573–87577); Río Sinaloa at Guasave (A.M.N.H. Nos. 84080–84083; T.C.W.C. No. 24232); Rosario (K.U. Nos. 73579–73583; U.I.M.N.H. No. 6391); 0.5 mile east of Rosario on Río de Baluarte (U.U. No. 3788); 3 miles east-northeast of Rosario on Río de Baluarte (S.U. Nos. 24001, 24002); 7 miles northwest of Rosario (T.C.W.C. Nos. 12610–12616); 9 miles southwest of Rosario on Chametla Road (U.A.Z. No. 14804); Teacapán and 1 mile east of Teacapán (L.A.C.M. Nos. 7147, 7150–7166); Villa Unión (K.U. No. 78911; L.A.C.M. Nos. 7140–7143); 1.4 miles northwest of Villa Unión (L.A.C.M. No. 7124); approximately 25 miles northeast of Villa Unión (S.U. Nos. 23996–24000).

SONORA: Arroyo Cuchujaqui southeast of Alamos (A.S.U. No. 6099; L.A.C.M. No. 25195; L.B.S.C. Nos. 600723-9, 600723-10; M.V.Z. Nos. 71358–71360); Río Mayo at Navojoa (A.M.N.H. Nos. 84074–84077; U.I.M.N.H. Nos. 81138–81141; one unnumbered specimen); Río Yaqui, 3 miles north of Ciudad Obregón (A.M.N.H. No. 84159); Río Yaqui, 3 miles west of Esperanza (K.U. No. 47567); Río Yaqui at Hornos, 11 miles north of Esperanza (L.A.C.M. Nos. 7120, 7121).

Fugler and Dixon (1961, p. 20) reported four specimens of *Natrix v. valida* from Eldorado, Sinaloa, listed as U.I.M.N.H. Nos. 46972–46975. According to Dorothy Smith, of the University of Illinois Museum of Natural History (personal communication), the last two numbers (U.I.M.N.H. Nos. 46974, 46975) are assigned to snakes of the genus *Typhlops*, so obviously there has been an error in cataloguing or recording data.

A specimen of *valida* catalogued as from "67 miles west and southwest of Durango on road to Mazatlán" (U.M.M.Z. No. 123371) may actually be from the vicinity of San Blas, Nayarit, according to Kenneth Baker to whom it is credited. Baker (in a personal communication to Frederick R. Gehlbach) suggested the possibility that this snake was accidentally placed in the same container with snakes of other species that were caught west of El Salto, Durango. In any event it is omitted from the list of localities above.

Two extralimital records for *valida* in the literature are based on misidentifications. Van Denburgh (1922, p. 786) called attention to the fact that U.S.N.M. No. 4650, reported from Rabeh Valley, Utah, by Cope (1900, pp. 984, 986), is actually a specimen of *Thamnophis ordinoides* (=*elegans*) *vagrans* with a divided anal plate, an anomaly that occurs with considerable frequency in at

[1] E. H. Taylor's statement (1936, p. 505) that Presidio is on the "Río Mazatlán" about 50 miles south of Mazatlán cannot be correlated with the geography of the region. Aside from the fact that interpreting the locality literally would place it well out in the Pacific Ocean, a distance of 50 miles in a southerly direction along the coast of Sinaloa would be well beyond Rosario and the Río del Baluarte. The Presidio de Mazatlán, which was renamed Villa Unión in 1828 (García Cubas, 1898, p. 433), "se halla situada á la izquierda del Río del Presidio, á 26 kilómetros S. E. del Mazatlán." The name "Presidio" survived, however, as the designation for the railroad station serving Villa Unión (American Geographical Society of New York, 1940, Guadalajara sheet), and, as Taylor traveled by "autovia" on the railroad, he presumably alighted at or near the station. Under the circumstances it is advisable to state the locality as "near Presidio, about 15 miles east-southeast of Mazatlán," and to assume that "50" was either a *lapsus* for "15" or an incorrect estimate of the distance.

least one other Utah locality (Tanner, 1950, pp. 195–196). Dunkle and Smith (1937, p. 3) reported *valida* (E.H.T.-H.M.S. No. 5408) from the Río San Pedro, midway between Chihuahua and Naica, Chihuahua, but this specimen is actually a garter snake, *Thamnophis rufipunctatus*.

Identification

The nominate race of *Natrix valida* is distinguished by its gray or brown dorsal ground color, lack of pale longitudinal stripes, and a high number of ventral scutes. The dorsum normally is gray, grayish brown, or (in some young specimens) yellowish brown; it is seldom dark brown or rich chocolate brown as is commonly the case in *isabelleae*. There is no pale middorsal stripe as in *thamnophisoides*. The scales of the lowermost two or three rows on each side of the body in *valida* are usually the same color as or only slightly paler than the ground color of the middorsal area; they rarely produce the effect of pale lateral stripes as they do in specimens of *isabelleae*. The number of ventral scutes averages about seven more (in both sexes) in *valida* than in *isabelleae* (table 1), the only other mainland race with which *valida* is apt to be confused. (The chief diagnostic characteristics are delineated on chart 4; for data on other meristic differences between *valida* and *isabelleae*, see pp. 101–102 and fig. 2.)

Scutellation

Scale counts in *valida* may be summarized as follows: Ventrals in males, 136 to 150, mean 141.7; in females, 132 to 147, mean 140.3. Anal plate divided in all specimens. Subcaudals in males, 70 to 86, mean 77.8; in females, 61 to 78, mean 70.4.

The dorsal-scale formula is normally 19–17, and deviations are few. Among 136 males one has a count of 20 and another has a count of 21; among the females 3.9 per cent have counts of 20 and 4.7 per cent have counts of 21. In all cases the increases are for the length of a few or relatively few scales only. A reduction to 16 rows posteriorly occurs among 6.6 per cent of the males and 4.7 per cent of the females, and to 15 rows among 2.2 per cent of the males and 1.6 per cent of the females.

Dorsal-scale reductions among 10 males are:

19 3+4 (71–81)—*17* (139–150)

Scale reductions among 10 females are:

19 3+4 (72–82)—*17* (140–146)

Supralabials usually eight, rarely seven or nine. Infralabials usually 10, but 11 in 5.3 per cent of the counts; rarely nine. Normally only a single preocular, but there are two in 6.1 per cent of the counts, and one abnormal specimen has a count of four. Normally three postoculars; two in 7.6 per cent of the counts; a count of one in one specimen and a count of four in two. Almost invariably a single anterior temporal, but one specimen has two on one side of the head. Temporals in second row usually two, in many cases three (23.3%), and in very rare instances one. Two supralabials, the fourth and fifth, normally enter the eye, but there are some variations. The fifth and sixth enter in seven counts. Three scales, the fourth, fifth, and sixth, enter in three counts, and single scales, usually the fourth, enter in seven counts.

Coloration and Pattern

Probably in part because of the much larger sample available, the coloration and pattern variations are greater in this taxon than in either of the other two races from the Mexican mainland.

Among adults the dorsal coloration may be any one of numerous tones of medium to pale gray or olive gray (Citrine-Drab, Grayish Olive, Olive-Gray) to brown (Sepia). In many, the entire dorsal surface is essentially uniform except for the numerous dark spots that are arranged in four longitudinal rows. In some specimens the lowermost two or three rows of scales on each side of the body are paler and grayer than the middorsal area. The contrast between the two shades, however, is not great. The venter is usually unmarked, and it varies from pale grayish brown to dull yellowish.

The general coloration of two adult females from the Río Mayo at Navojoa, Sonora, may be summarized as follows: Dorsal ground color, including top of head, brown (Sepia). Lower three rows of scales slightly paler (Saccardo's Umber). A small amount of reddish brown pigment (close to Mikado Brown) on the scales immediately

posterior to the temporals and parietals. Dorsal markings black. Supralabials brown, with black sutures along their edges. Infralabials similar but blending inferiorly with the pale yellow of the throat. Belly pale grayish brown except for a narrow yellowish area paralleling the posterior border of each ventral. Under side of tail similar but slightly darker and with a longitudinal area of medium grayish brown along the common sutures of the subcaudals. Eye: Pupil black, narrowly ringed with gold; iris brown (between Sepia and Saccardo's Umber). Tongue: Pink at base, mottled with gray dorsally; tips very dark gray, almost black.

The general coloration of an adult male (also from Navojoa) may be summarized as follows: Dorsal ground color Deep Olive; top of head Brownish Olive. Lower three rows of scales slightly paler (Citrine-Drab). Dorsal markings black or very dark gray. Supralabials Light Brownish Olive, with black lines along the sutures between them. Infralabials similar, but blending inferiorly with the pale yellow (Marguerite Yellow) of the throat. Belly pale brownish in general, but with three ventral pattern elements discernible: (1) lateral edges of ventrals Citrine-Drab; (2) dusky stippling on anteromedian edges of the ventrals, these dark areas collectively imparting the suggestion of a faint dusky midventral stripe; and (3) paler areas (Olive-Buff) on the remaining portions of the ventrals. Under side of tail similar, but with a continuous dusky area along the common sutures of the subcaudals. Eye: Pupil black, very narrowly ringed with yellow; iris Deep Olive in the area immediately surrounding the pupil, but strongly speckled with gold over much of the rest of its surface. Tongue: Base pink except for a narrow, longitudinal, black line on its dorsal surface; tips black.

The number of dark spots in one of the lower rows among 10 males varies from 54 to 82, mean 72.8; among 10 females, from 53 to 76, mean 67.2. There is a strong tendency for the lower counts to occur on specimens with the larger, more conspicuous spots.

Variations in Pattern

The dark dorsal spots, although normally small and often inconspicuous, are large in some specimens. Typically each of the smaller spots consists of a black or very dark brown V on the anterior corner of a single scale. Even if the spots are larger and more black pigment is involved, there is a strong tendency for the dark maculations to follow the perimeters of individual scales, thus leaving the centers gray or brownish and matching the dorsal ground color. Such is the case even in strongly patterned individuals such as one from Rosario, Sinaloa (K.U. No. 73581). In this snake the dark spots of all four longitudinal rows are subequal in size, and each spot involves the length of about one and one-half scales (longitudinally) and three or four scales (transversely). None of the spots is solid black. Instead they result from black pigmentation on the edges of groups of adjacent scales, with the black largely confined to the anterior and the upper and lower edges of the scales. Other snakes from Rosario have much smaller spots. The size of the markings appears to be a matter of individual variation, although there is some local variation, with the spots averaging smaller in snakes from some localities and larger in those from others. No evidence of a geographical cline in this characteristic was detected, however, during the examination of the available material. The spots are usually most readily seen in young adults. They tend to be less noticeable in large adults in which there may be a darkening of the entire dorsal surface.

Rarely and in widely scattered localities the head or the head and neck in individual specimens may be considerably darker than the remainder of the dorsum.

Although the venter in the subspecies *valida* is best described as unmarked, with the general belly color varying from yellowish in juveniles to gray or yellowish gray in adults, dark pigmentation appears on the venter of occasional specimens in the form of dark stippling or cloudy gray markings. These vague dark markings may appear in snakes from virtually any part of the range. They were noted in snakes from such widely scattered localities as the Arroyo Cuchujaqui and the Río Mayo in Sonora, from near Los Mochis, the Río Sinaloa, Culiacán, Eldorado, Mazatlán, Escuinapa, and Teacapán, all in Sinaloa, and from near

Acaponeta in Nayarit. One snake from Teacapán (L.A.C.M. No. 7147) and two from Escuinapa (C.A.S. Nos. 95800, 95801) are especially noteworthy, for each has a broad black longitudinal stripe on its venter that closely matches the markings of some of the melanistic specimens from San Blas, Nayarit (p. 94).

Size and Sex

The 10 largest females have measurements as follows: Head-body length, 867 mm. (total length 1096+ mm.); 819 mm. (1068 mm.); 750 mm. (987 mm.); 724 mm. (959 mm.); 714 mm. (929+ mm.); 708 mm. (929 mm.); 708 mm. (760+ mm.); 706 mm. (854+ mm.); 695 mm. (850+ mm.); and 694 mm. (925 mm.). Comparable measurements for the 10 largest males are: 579 mm. (774 mm.); 572 mm. (772 mm.); 556 mm. (747 mm.); 550 mm. (690+ mm.); 547 mm. (720 mm.); 546 mm. (719+ mm); 542 mm. (738 mm.); 535 mm. (725 mm.); 514 mm. (686 mm.); and 513 mm. (680 mm.).

Among 69 captive-born young that could be measured, the total lengths varied from 197 mm. to 223 mm., and the means, calculated separately for the three litters involved, were 203.9 mm., 208.8 mm., and 214.0 mm., respectively (table 21). The sex ratios among the newborn young were 12 males to 10 females, 21 males to 13 females, and seven males to eight females in each litter, respectively. Dixon and Webb (1965) reported on the second (largest) litter, but through an error they gave the total length of the mother as 1444 mm. Actually this snake (T.C.W.C. No. 24197) measures 929+ mm. in total length and 714 mm. in head-body length; the tip of the tail is missing.

Several wild-caught juveniles had measurements falling within the size limits of the young of the three litters mentioned above, but only one, measuring 175 mm. in total length, was smaller (S.U. No. 23970 from 10 to 11 miles southeast of Navolato, Sinaloa).

Tail length/total length ratios for males of all sizes are 0.23–0.28 (0.264); for females, 0.22–0.27 (0.248).

Intergradation with *thamnophisoides* and *isabelleae*

Snakes of the *Natrix valida* complex from San Blas and Rosamorada, both in Nayarit, exhibit pattern variations on which comments were made in a previous publication (Conant, 1961, p. 8). Numerous additional localities are now represented, and the available sample is far larger. From a study of this it is apparent that intergradation among *valida*, *thamnophisoides*, and *isabelleae* occurs through a considerable area involving the southern portion of the Marismas Nacionales in Nayarit southward to where the Pacific coastal plain abruptly terminates against the mountainous headlands south of San Blas. In this same region the populations are characterized by a considerable degree of melanism, with black or very dark gray or very dark brown pigment present on the venter or dorsum, or both (pl. 2, fig. 2, pl. 10, figs. 5–8). Material from farther south also suggests mixed affinities, with evidence of middorsal striping, as in *thamnophisoides*, present in a few specimens from Las Varas, Nayarit, and indications of intergradation between *valida* and *isabelleae* in a sample from Puerto Vallarta, Jalisco, as reported by Smith and Grant (1958, p. 22). The distribution of this intergrading complex, based on the available material, is shown on map 5, and its components are discussed in detail below. Scale counts are summarized separately (pp. 96, 97, tables 1, 2, 4, 6–10).

San Blas Population

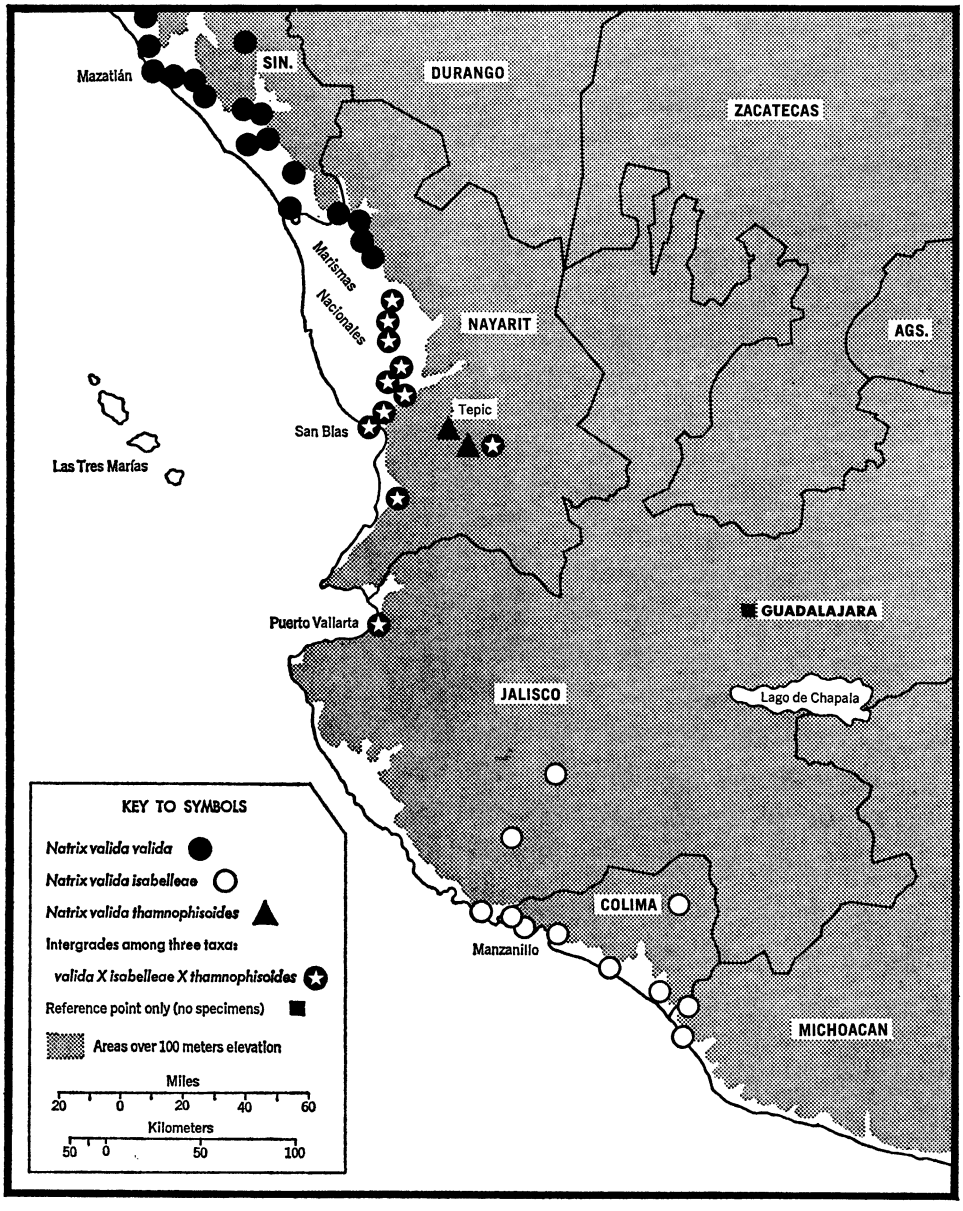
Many snakes have been collected in the vicinity of San Blas—at the village itself, from boats making the so-called jungle cruise to the southeast, and along the paved road leading eastward toward higher ground. Many were taken near the point where the road to Matanchen branches off to the south or, nearby, where the paved road passes through a marshy area bordered in part by mangroves. Various collectors have recorded their localities as "near San Blas," "1 to 4 miles east of San Blas," "San Blas road," and so forth, during road collecting at night. Because many of these data obviously are not precise, I have lumped them together.

The locality records and museum numbers for 44 specimens studied in detail are:

Nayarit: Matanchen, near San Blas (U.S.N.M. No. 147985); San Blas and eastward along the road (Mexico No. 54) for a distance of about 5 miles (A.M.N.H. Nos. 87579, 87580, 101364; C.A.S. Nos. 95802,

95839, 95840; E.A.L. No. 79; I.N.H.S. No. 9773; K.U. No. 67692; M.M.N.H. No. 2132; M.S.U. No. 7871; M.V.Z. Nos. 75806–75809, 77901, 78754; N.H.S.S.D. No. 52905; U.I.-M.N.H. Nos. 62737–62739, 62813, 62814, 81143–81148, 81564–81568; U.M.M.Z. Nos. 114638, 118914; U.S.N.M. No. 153768); 3 miles southeast of San Blas (L.B.S.C. No. 600711-1); 7 miles southeast of San Blas (U.C.M. Nos. 9110–9112); near Arroyo Guaristempo on road to San Blas (C.A.S. No. 97359); San Blas turnoff from Mexico Highway No. 15 (U.I.M.N.H. No. 81563).

The two snakes found on the road at a considerable distance from San Blas (the last two listed) have typical *valida* markings. Among 41 specimens from the immediate vicinity of the village the pattern variations may be summarized as follows: In 19 the general coloration and patterns are similar



MAP 5. Locality records for the *Natrix valida* complex in Nayarit and adjacent areas.

to those of more or less typical specimens of *valida*, except that three have dorsal surfaces of a richer brown coloration than is normal in *valida*, and they thus resemble populations of *isabelleae*. In two specimens there are suggestions of pale middorsal stripes such as are prominent in *thamnophisoides*. In one of these (U.C.M. No. 9111) a faint stripe a scale in width is present through much of the length of the body. In the other (C.A.S. No. 95802) there is a faint stripe on the first seven scales posterior to the parietals, and distinct pale lateral stripes are also present.

Melanism occurs to varying degrees in the other 20 specimens. In two, an adult female and a juvenile male, both the dorsal and ventral surfaces are nearly uniform black, but, when they are placed in fluid, both show indications of black dorsal spots against a very dark gray ground color. The venter in the juvenile is unmarked, but in the adult there are very small, dark gray areas at the lateral edges of the otherwise virtually black ventrals. Among the other 18 melanistic specimens the amount of black or very dark pigment varies considerably. Some are chiefly dark both dorsally and ventrally (pl. 10, figs. 5, 6). Some are less dark above but are marked with an irregular dark stripe running the length of the venter from throat to tip of tail (fig. 3 and pl. 10, fig. 8). Others, although superficially similar to typical *valida*, have the dorsal spots larger and more conspicuous, partly because entire scales may be black instead of only their edges or perimeters. A comparison of the many specimens suggests that melanism may develop as follows: Dark pigment appears first on the dorsal surface of the head or as an intensification of the black dorsal spots; in more advanced cases it involves much of the dorsal surface, either in the form of relatively large, blotchlike markings on a slightly paler ground color or in a general darkening of the entire dorsum. Concurrently, black pigment develops on the chin, and an irregular dark line extends the length of the venter; in extreme cases melanism is virtually complete and the entire animal is dark. An exception involves the lower two or three rows of scales, for in 17 of the dark snakes there are at least suggestions of pale lateral stripes. The dorsal surface of the head is black or very dark brown in 17. Dark longitudinal stripes, varying in width from the central one-seventh of the venter to one-half or more, are present in 14 snakes; in four the venter is all black or virtually so. (See fig. 3.)

There apparently is no sexual or ontogenetic variation involved among the melanistic snakes, for both sexes are represented in all categories, and one of the darkest specimens, the juvenile male mentioned above, measures only 210 mm. in total length, which approximates the mean length of newborn young (table 21).

The general coloration of a melanistic

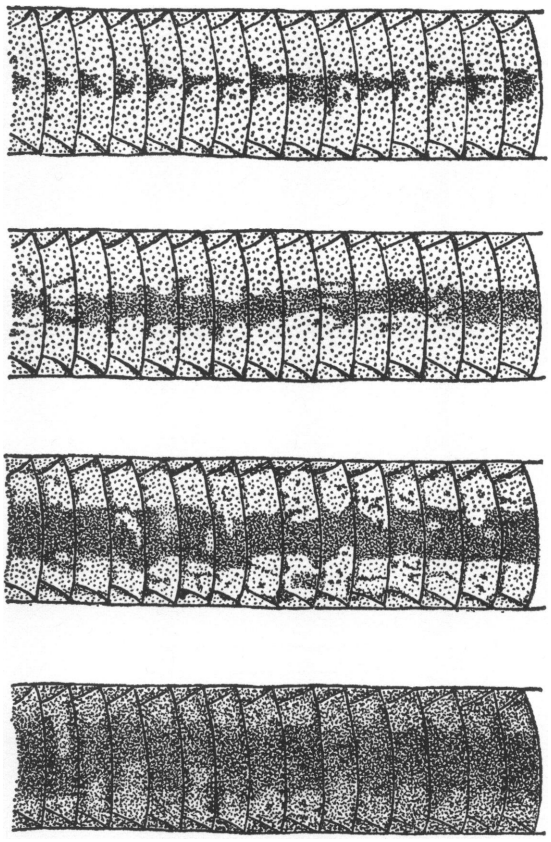


FIG. 3. Variation in the amount of dark pigmentation on the venter of melanistic specimens of the *Natrix valida* complex from the vicinity of San Blas, Nayarit. Semidiagrammatic drawings of 15 ventral scales at midbody in the following specimens: A. U.I.M.N.H. No. 62814. B. I.N.H.S. No. 9773. C. M.V.Z. No. 78754. D. A.M.N.H. No. 101364.

adult female from 2.1 miles east of San Blas, Nayarit (pl. 10, figs. 5, 6), may be summarized as follows: Over-all dorsal coloration dark brown, composed of relatively large black spots on a ground color of Brussels Brown that gradually changes to Sudan Brown on a virtually unmarked lateral stripe occupying the two lowermost rows of scales. Top of head unmarked and very dark brown (almost black). Supralabials dull medium brown (Saccardo's Umber), heavily marked and stippled with black. Chin, throat, and labials black but surrounding a white area that is dusted with brownish black; the white area is chiefly on the gulars but also includes some of the scales farther posteriorly. First 20 ventrals black, remainder of belly dark gray and consisting of heavy dark gray stippling over a ground color of medium pale brown, but very little brown shows through the stippling. Lateral tips of ventrals Sudan Brown, matching the coloration of the lateral stripes. A narrow, wavy black line along the common sutures of the ventrals and the first row of scales. Lateral edges of the anal plate and the ventral immediately preceding it dull orange-brown (Sayal Brown). Under side of tail dark gray, almost black. Eye: Pupil black; iris very dark brown. Tongue: Black, grayish at tips (no pink at base as is normal in *valida*).

Rosamorada Population

Material from Rosamorada southward to the general vicinity of Santiago Ixcuintla, a distance of less than 30 airline miles, has been lumped together for purposes of comparison. The locality records and museum numbers for the 19 specimens of this group are:

Nayarit: Chilapa (A.M.N.H. No. 75752); near the Río San Pedro west of Ruiz on Mexico Highway No. 15 (T.N.H.C. No. 29756); 3 miles north of the Río San Pedro, west of Ruiz, on Mexico Highway No. 15 (A.M.N.H. No. 101365); near Rosamorada (A.M.N.H. Nos. 84084–84090); 1.6 miles south of Rosamorada (U.A.Z. No. 14479); 4 miles southeast of Santiago Ixcuintla on the Estación Nanchi road (S.U. Nos. 24006, 24007); 4 miles north-northeast of Tuxpan (K.U. No. 67693); 12.4 miles north of the Tuxpan road on Mexico Highway No. 15 (M.V.Z. No. 71361); east-northeast of Villa Hidalgo (S.U. Nos. 24008, 24009, 24109, 24110).

Color patterns among these 19 snakes may be summarized as follows: Eleven fall within the range of variation of *valida*. Pale middorsal stripes are present in seven; these are prominent (as in typical *thamnophisoides*) in two, they are narrow or weakly defined in three, and they extend for only short distances on the neck in two. In the nineteenth snake there is a large amount of black on the belly (pl. 2, fig. 2) as in many specimens of the San Blas population.

Future collecting along the upper borders and within the depths of the Marismas Nacionales may show that the area of intergradation extends farther north than indicated (map 5). No material presently available from north of Rosamorada exhibits any of the characteristics of *thamnophisoides*, but evidence of melanism appears in samples from Teacapán and Escuinapa in the form of irregular dark stripes extending the length of the venter. Also, in one of the snakes from Escuinapa, a few of the black dorsal spots occupy entire scales, a characteristic that is rare among pure populations of *valida* but occurs in a number of the melanistic individuals from San Blas.

Other Intergrading Populations

Snakes from a few other localities are classified as members of intergrading populations for several reasons. The locality records and museum numbers for the 21 specimens involved are as follows:

Jalisco: Las Peñas, Vallarta (A.M.N.H. No. 19307); Puerto Vallarta (U.I.M.N.H. Nos. 41449–41456).

Nayarit: Laguna de Santa María del Oro (C.A.S. No. 95766; T.U. No. 18463); 1.5 miles south of Las Varas (C.A.S. No. 95829–95838).

Smith and Grant (1958, p. 22) reported on the series of eight specimens from Puerto Vallarta soon after they were preserved, stating that some were dark chocolate brown whereas others were pale. The general dorsal colorations and an analysis of the ventral counts caused them to consider the sample as an intergrading one. The snakes are now faded and shedding their scales, but in two

there are distinct pale lateral stripes like those so clearly evident in populations of *isabelleae* from farther southeast in Jalisco. The snake from Las Peñas, which apparently had been decapitated before it was found and preserved in 1920, is now pale olive-gray and similar to many long-preserved specimens of the subspecies *valida*.

Among the 10 snakes from Las Varas there are pattern anomalies although they resemble population samples of *valida* in general appearance. A pale middorsal stripe is present in the three largest females. It is faint and narrow in two, but in the third it is more than a full scale in width and is comparable with that of some of the less well-marked individuals of *thamnophisoides*. In six specimens, including one of the three males of the series, there is a wavy black line along the common border of the ventrals and the first row of scales, as in some of the snakes from San Blas. The black line is strongly evident in the two largest females, one of which also has similar, although intermittent, black lines along the common border of the scales of the first and second rows and another intermittent black line along the common border of the second and third rows of scales. In four snakes the black line at the edge of the ventrals, although present, is weak or narrow or only evident posteriorly.

The two snakes from the Laguna de Santa María del Oro are of interest because of the locality at which they were collected. Although it is at a relatively low altitude (2350 feet, or 716 meters) in the drainage of the Río Grande de Santiago, it is almost within sight of the Volcán Sangangüey near the foot of which we have taken *thamnophisoides*. Intergradation would be expected, but there is only slight evidence that it occurs. The larger of the two snakes (T.U. No. 18463), a female measuring 657 mm. in total length, is nearly uniform in coloration, with the small black markings obscure and no trace of striping. The smaller specimen (C.A.S. No. 95766), a juvenile male measuring 207 mm. in total length, is well spotted and has a faint middorsal stripe in the nuchal region. When more material from this volcanic lake in an old crater (a caldera?) becomes available the extent of intergradation will be better known.

Summary of Intergradation as Suggested by Color Patterns

Intergradation involving three races of *Natrix valida* (*valida*, *thamnophisoides*, and *isabelleae*) occurs from Rosamorada, Nayarit, at the eastern edge of the Marismas Nacionales, southward to Puerto Vallarta, Jalisco, and southeastward in the valley of the Río Grande de Santiago at least as far as the Laguna de Santa María del Oro. Evidence of the influence of *thamnophisoides* occurs in population samples on many sides of the range of this upland form, even among some from very low elevations. Characteristics of *isabelleae* appear at Puerto Vallarta and (weakly) as far north as San Blas. Melanism is common within the intergrading populations, at least in the lowlands from San Blas northward. Snakes with black ventral stripes also occur at Teacapán and Escuinapa in the northern portion of the great delta and swampland complex of southern Sinaloa and northern Nayarit.

Scutellation in the Intergrading Populations

All the intergrading populations (from San Blas, Rosamorada, Puerto Vallarta, Las Varas, and the Laguna de Santa María del Oro) have been lumped together in the scale data presented in tables 1, 2, 4, and 6–10.

Scale counts in the intergrading populations may be summarized as follows: Ventrals in males, 134 to 145, mean 139.2; in females, 132 to 144, mean 136.5. Anal plate divided in all specimens. Subcaudals in males, 70 to 82, mean 76.4; in females, 64 to 74, mean 69.4.

The maximum number of scale rows is 19 in most specimens of both sexes; exceptions are maximum counts of 21 in two males among 33 specimens and in three females among 49 specimens. The minimum number is 17 except in one male among 33 specimens and in three females among 49.

Supralabials normally eight, rarely nine, and very rarely seven. Infralabials usually 10, but nine or 11 in some cases. Normally only a single preocular, but two in some cases; postoculars three, two in some, and four in rare circumstances. Invariably a single anterior temporal. Temporals in second row

two (69.8%) or three (29.6%), but there is also a single count of one among 162 counts. Normally the fourth and fifth labials enter the eye, but the fifth and sixth enter in five counts among 164.

Tail length/total length ratios for males of all sizes are 0.24–0.29 (0.264); for females, 0.23–0.27 (0.247).

Ecology and Natural History

The completion during the late 1950's of the main highway roughly paralleling Mexico's western mainland coast (Mexico No. 15) has permitted many herpetologists to work in a region that previously had been difficult of access. Considerable information on the distribution and natural history of *valida* has accumulated as a result, and we now know that it is an abundant and easily collected snake throughout much of its range. More specimens are available for study than those of any other form of *Natrix* occurring in Mexico. Several persons have obtained small series during an evening's field activities along some of the streams, and road cruising at night has sometimes yielded large numbers, including many that had been killed by passing vehicles. For example, Allen E. Greer (personal communication) reported that "*Natrix valida* and *Thamnophis cyrtopsis* were very abundant on the paved roads at night in the Navolato-Culiacán-Eldorado triangle." The first rains of the season came to the area about the time he arrived in mid-July, 1963, and he stated that "the *N. valida* were so abundant that, had we collected all we saw, we would easily have had over a hundred specimens."

Much of the range of *valida* lies within the thorn-forest province of Leopold (MS), a region characterized by small deciduous trees that stand stark and leafless through most of the dry season. When we worked south of Culiacán, Sinaloa, on June 30, 1959, the trees were sprouting new leaves in response to the onset of the rainy season. This water snake also occurs within the borders of the tropical deciduous forest, at Chupaderos in Río de Baluarte drainage, for example. The populations of *valida* are so closely associated with water, however, that their distribution cannot readily be correlated with zones of vegetation. In the northern part of the range, such streams as the Ríos Yaqui, Mayo, and Fuerte support tenuous gallery forests through otherwise arid terrain (pl. 19, fig. 2). Farther south on the coastal plain such streams as the Ríos Piaxtla and Quelite traverse areas where the thorn forest is well developed, and their gallery forests are less conspicuous against the general landscape.

Most of the many streams that rise in the highlands are subject to severe flooding, and sudden and dramatic alterations of the habitat often occur during the rainy season. Typically, the riverbeds crossing the coastal plain are broad and flat, and, at least from June through September, the flow may be continuous, but during the dry season the streams may be reduced to intermittent pools, the latter often situated close to shore where the current has cut into the banks. Depending on the amount and frequency of precipitation in the sierras, a river may rise with great rapidity and overflow its banks one day and quickly subside the next, exposing broad expanses of mud, sand, and gravel. Conditions observed along the Río Quelite, Sinaloa, near the highway bridge during periods of both high and comparatively low water serve as an example.

During the early evening of September 8, 1961, although much water was flowing, it was obvious from marks on the bridge piers that the level had been much higher very recently. Five specimens of *valida* were found lying on brush piles and snags in the dark sprawled out much as they would have appeared if they had been basking in the sun. On September 23, 1961, the river was in flood, with a fast current flowing, and collecting was impossible. The following day the river had dropped considerably (pl. 19, fig. 1), and *valida* was again in evidence.

Natrix valida obviously is adapted to the flash floods and swift currents that occur during the summer months. Individuals usually were seen in or close to shelters where they could take refuge quickly or climb upward to escape from any sudden rise in water level. We observed them at night in brush or vegetation that was emergent and adjacent to the shore, and saw them swimming close to banks where trees and shrubs overhung the water. We never encountered

these snakes in strong currents or saw them in deep water even in quiet eddies near shore, although a few dove into fast-flowing water in their efforts to escape. Other collectors have found them beneath stones and debris along streams after floods.

Robert G. Webb caught several specimens of *valida* in the branches of buttonbushes (*Cephalanthus*) overhanging the water near where the highway (Mexico No. 40) crosses the Río Chupaderos about 5 miles southwest of Copala, Sinaloa. A photograph he made of the locality shows a rocky, nearly vertical bank with a cluster of buttonbushes growing in shallow water at the edge of the stream. This is the highest known locality (about 244 meters) for the subspecies *valida*, but it undoubtedly ascends considerably higher in some of the barrancas.

The rivers in the northernmost part of the known range of *valida*, the Ríos Yaqui, Mayo, Fuerte, and Sinaloa, are now controlled, at least in part, by dams built for irrigation purposes (see map in Dozier, 1963, p. 549), and their flows are reduced, except under unusual circumstances, in comparison with other rivers farther south. McCoy, Branson, and Sisk (1960, p. 130), in describing the Río Yaqui 3 miles north of Ciudad Obregón, Sonora, as they saw it in mid-August of 1959, stated that "the reduced stream flows over a bed which once contained a much broader river" and the "bed is richly vegetated by aquatic and semi-aquatic plants" which they listed by generic names. They further stated: ". . .the river is also subject to strong influence from the nearby Gulf of California, and collections of fishes from this site contain several marine and estuarine species. This association could be generally described as a coastal plain-river bottom type." Miller (1958, pp. 214–215) discussed the fish fauna of the Río Yaqui and its origins.

We collected *valida* in the Ríos Mayo, Fuerte, and Sinaloa during late June of 1959 and found the streams low but flowing steadily. The Mayo and especially the Sinaloa were choked in part with aquatic vegetation through which water snakes were foraging.

No data are available to indicate whether *valida* occurs at the mouths of the rivers in the northern part of its range, but it probably does. Farther south, near Culiacán, near Mazatlán, and from at least the vicinity of Escuinapa, all in Sinaloa, to southeast of San Blas, Nayarit, it is abundant along the coast and even enters brackish water. Probably it occurs throughout much of the vast complex of swamps and waterways of the Marismas Nacionales that extend from near the mouth of the Río de Baluarte southward almost to the Río San Pedro. This region has been little explored by naturalists, however, and such records for *valida* as exist are chiefly from along the highway where it borders the swamps and their environs on the east (map 5). It is likely that many of the aquatic and semiaquatic components of the fauna, including *valida*, retreat to the Marismas during the dry season but migrate for at least short distances eastward into some of the small temporary streams and large pools that form during the rainy season. When we drove through the region on July 1, 1959, roadside ditches and small watercourses were dry or virtually so, but by July 10, under the influence of heavy rains, these had filled. Our field notes for the latter date include the following entry: "The roadside ditches, which are actually broad, shallow borrow pits, are now filled with water to form a long, nearly continuous pond on each side of the highway. The vegetation in some of these indicates that portions of the ponds may be semi-permanent. There were jacanas in most of them. A semiaquatic animal, such as *Natrix*, could readily migrate from one river system to the next at this time of year. This would not be possible farther north where desert conditions prevail [except where altered by man] and streams are far apart."

The habitats at and near San Blas, Nayarit, are of special interest because of the pattern polymorphism occurring in the *Natrix valida* population in that vicinity (see pp. 93, 94). Some 42 specimens have been collected, mostly along the paved road east of the village, and many of them were taken where it passes through a large marshy area composed in part of shallow pools bordered by mangroves. Dense stands of mangroves tower above the gravel road to Playa Matanchen near where it branches off to the south a short distance east of San Blas. There are also dense masses of mangroves along the main road which, on the evening

of September 4, 1961, were being used by hundreds of birds (herons of several kinds, anhingas, ibises, cormorants, and grackles) that arrived to roost just before dark. During our visit the water was high, evidently as a result of heavy daily afternoon thundershowers in the uplands to the east, and water was flowing through all the culverts and even passing across the surface of the road.

A water sample was collected in one of the deeper, mangrove-bordered pools along the paved road within a few feet of where we obtained a specimen of *valida*. Through the kindness of Dr. John Cairns, then of the Department of Limnology of the Academy of Natural Sciences of Philadelphia, the chloride concentration of the sample was determined as 242 parts per million. According to Cairns (personal communication): "...this indicates a low salt content, but much saltier than fresh water. Some persons can detect concentrations as low as 50 parts per million, but the chemoreceptors of other persons cannot detect less than 135 to 150 parts per million."

The general appearance of the area and the presence of land crabs suggest that, at least in some pools, the water may be distinctly brackish during the winter-spring dry season when it is not diluted by runoff from summer storms. Four water snakes (M.V.Z. Nos. 75806–75809) were collected near San Blas from December 20 to 22, 1962, inclusive, by Joe La Pointe, who found them near thick stands of mangroves. He also saw another specimen "wrapped around a fork in a mangrove about 20 centimeters above the water, into which it escaped" (personal communication). One other *Natrix* (M.V.Z. No. 77901) was collected on April 11, 1965. All other specimens of the *valida* complex from near San Blas were taken during the summer, from June to September, inclusive. No winter-collected water samples are available for analysis, and no attempt has been made to observe the behavior of *valida* in salt water, but this normally fresh-water reptile may have developed the ability to survive in water containing high concentrations of chlorides, just as the normally fresh-water *Natrix sipedon sipedon*, of the northeastern United States, apparently has done on the islands of the Carolina Banks (Conant, 1963a, pp. 29–32). Pettus (1958, p. 211) stated that *Natrix sipedon* (=*fasciata*) *clarki*, a form normally found in salt or brackish water, refrained from drinking salt water under laboratory conditions.

Norman J. Scott, Jr., collected two specimens of *valida* (L.A.C.M. Nos. 7147, 7150) in brackish water at Teacapán, Sinaloa, in 1960. Other museum material may also be from brackish habitats, although the available information does not so indicate. A number of snakes have been taken close to the sea, near Eldorado and Mazatlán, for example, where estuarine conditions are present and storms must occasionally drive salt water into what otherwise may be essentially fresh-water habitats. Ecological studies on *valida* and other semiaquatic animals that inhabitat the low-lying coastal areas in Sinaloa and Nayarit would be of considerable interest.

Several persons have found *valida* in the open during daylight hours. T. Paul Maslin, for example, saw several and collected three by shooting "as they basked on the lush foliage in open sunlight bordering the sloughs on the way to the lagoon," while he was traveling in a power boat southeast of San Blas on June 16, 1956.

In contrast, during our own field work, we saw no specimens of *valida* abroad in the daytime, probably in large part because most of our searching along the roads and rivers was done at night. Snakes that were in motion almost invariably continued to move when a light struck them; they sometimes followed their original course but occasionally swam toward the beam of light. Snakes that were lying motionless when first seen almost always remained inert, especially if they were in vegetation. The drab gray or gray-brown coloration blends well with mud, sand, or dead-stick backgrounds, and the dark dorsal spots are sufficiently ruptive to render the snake inconspicuous if it is partially concealed. All our specimens were caught in or close to water, but other collectors have reported finding *valida* at distances of up to 100 yards from the nearest pond or river in the southern part of the range.

High temperatures prevail along the west coast during the summer months, and we experienced diurnal highs of 40° C. and more during June at several localities. One such was at Navojoa, Sonora, but by 9:30 P.M. on

June 27, 1959, the air temperature had dropped to 29.6° C., and the water of the Río Mayo, where we caught four specimens of *valida*, was 30.4° C. The following evening along the Río Fuerte, north of Los Mochis, Sinaloa, the air temperature was 30.8° C., and the water in the river where two snakes were taken was 32.8° C. While we were engaged in field work in Sinaloa during the summers of 1959 and 1961, the lowest evening temperatures encountered were: air, 25.5° C.; water, 28.4° C.

According to Contreras Arias (1942), the source of the following climatological data, the northern part of the range of *valida* is hot and very dry, with a mild winter and a deficiency of rainfall at all seasons. Annual rainfall at Ciudad Obregón and Navojoa, both in Sonora, was 212 mm. and 396 mm., respectively, with most of it occurring from June to October; the mean annual and maximum recorded temperatures (the latter in parentheses) were 26.5° C. (43.5° C.) and 25.8° C. (53.3° C.) for the same two stations. Farther south temperatures are less severe, and there is more precipitation. From north to south the respective rainfall and mean annual and maximum recorded temperatures (the last in parentheses) for three stations were: Culiacán, Sinaloa, 605 mm., 24.4° C. (40.9° C.); Mazatlán, Sinaloa, 851 mm., 23.6° C. (33.4° C.); and Acaponeta, Nayarit, 1102 mm., 24.9° C. (40.0° C.). Most of the rain at all three southern stations falls from July to September, inclusive.

We and several other collectors have found the snakes most active for about an hour or two after dark, but we once caught them as late as midnight. Most appeared to be actively prowling in search of food, which apparently consists chiefly of fishes and amphibians. Several of a series of seven snakes caught July 10, 1959, near Rosamorada, Nayarit, were pursuing small fishes, and one of medium size disgorged an adult male of *Poecilia mexicana* Steindachner that measured 51 mm. in standard length. A large specimen of *valida* taken along the Río Quelite on September 8, 1961, disgorged a partially digested juvenile of *Gobiomorus maculatus* (Günther) measuring about 5 inches long. Another large water snake was caught in the act of swallowing an adult of *Bufo mazatlanensis* in the Río Mayo near Navojoa, Sonora, on June 27, 1959. A small individual of *valida* measuring 265 mm. in total length (tip of tail missing) was found on the road about 2 miles east of San Blas, Nayarit, on September 4, 1961, while it was attempting to swallow a large, freshly run-over *Leptodactylus melanonotus*. Large numbers of frogs of that species had appeared on the road during showers shortly after dark, and many were killed by passing vehicles, although the traffic was light. They also were being eaten by other predators, including *Leptodeira maculata*, raccoons, coatimundis, and opossums. *Rana pipiens* and *Leptodactylus melanonotus* have previously been reported as food animals (Conant, 1946, pp. 260–261). Captives ate leopard frogs and fishes of several species (see p. 131).

One night, immediately after turning our car around while road cruising near San Blas, we found a small dead *valida*, its light-colored belly upturned and thus conspicuous against the macadam road, in a spot where it had not been less than five minutes previously. No cars had passed, and its presence could be explained only by the possibility that some predator had dropped it there. The flesh of part of the head had been eaten away, and we suspected that a land crab might have been responsible. Semiaquatic birds must be important predators upon *valida*, for they were in evidence, sometimes in great numbers, at many of the localities where this snake was found.

Young were born in captivity on dates ranging from June 6 to August 1 (table 21). A female of *valida* (U.I.M.N.H. No. 81562), measuring 929 mm. in total length, was found dead on the road 15 miles east of Mazatlán, Sinaloa, on July 4, 1965, and apparently it had been run over as it was giving birth to young. It contains many full-term embryos, and there is part of a juvenile snake in the mother's cloaca.

Natrix valida isabelleae Conant

COLIMA WATER SNAKE

Plate 2, figure 1, plate 9, figures 7, 8

Natrix valida isabelleae CONANT, 1953, p. 7.

TYPE AND TYPE LOCALITY

A.M.N.H. No. 73171, holotype, an adult female collected October 8 or 9, 1949, in the

Laguna Coyuca at Pie de La Cuesta, Guerrero (Conant, 1953, p. 7); elevation virtually at sea level.

Range

Coastal regions from the vicinity of Cabo Corrientes in Jalisco southeastward to the vicinity of Acapulco, Guerrero (map 4). This taxon is probably widely distributed through the tenuous and frequently interrupted coastal plain from near the Bahía de Banderas to Acapulco, but the locality records are scattered. Such a pattern reflects the general inaccessibility of the region, but records probably will accumulate rapidly as various sections of the coastal highway are completed, as they did after the opening of the main road (Mexico No. 15) through Sonora, Sinaloa, and Nayarit. The presence of brackish- and fresh-water lagoons shoreward of the barrier dunes along the coast of Guerrero and Oaxaca suggests that *isabelleae* may range far to the east of its present known limit near Acapulco and thus parallel the range of the eleotrid fish *Gobiomorus polylepis* (Miller, 1959, p. 2, fig. 1) and the clingfish *Gobiesox mexicanus* (Briggs and Miller, 1960, p. 5, fig. 1). Comment on our failure to find water snakes in Oaxaca is made on page 5.

The known vertical range of *isabelleae* extends from sea level to approximately 1200 meters (3937 feet) at El Corcovado, northeast of Autlán de Navarro, Jalisco, in the valley of the Río San Pedro, a stream that becomes the Río Armería before it empties into the Pacific in Colima. Possibly the specimen (U.S.N.M. No. 31384) from Colima (state or city not indicated) is from the city of that name, which is at an elevation of 480 meters (1575 feet), and it has been plotted on maps 4 and 5 at that locality.

The locality data and museum numbers for the 59 specimens studied in detail are as follows:

Colima: Exact locality unknown (U.S.N.M. No. 31384); near Cihuatlán (A.M.N.H. Nos. 87571, 87572); near Cuyutlán (L.S.U.M.Z. Nos. 7878, 7886); 21.2 to 25.9 miles west-northwest of Manzanillo (L.S.U.M.Z. Nos. 7876, 7877, 7883); Río Rico, Manzanillo (A.M.N.H. No. 19590); 8 to 9 miles southeast of Tecomán (A.M.N.H. Nos. 94658–94660).

Guerrero: Near Acapulco (U.I.M.N.H. No. 28020[1]); near Acapulco airport (M.V.Z. No. 78753); 1.7 miles east of Coyuca de Benitez (U.M.M.Z. No. 119420); El Limoncito, 12 kilometers north of Acapulco (U.I.M.N.H. No. 18659); 2.9 miles southeast of Las Cruces (U.I.M.N.H. No. 81137); Pie de la Cuesta near the eastern end of the Laguna Coyuca, approximately 7 miles northwest of Acapulco (A.M.N.H. Nos. 73171–73178; C.M. Nos. 29650–29657; M.V.Z. No. 66224; U.F. No. 16544; U.M.M.Z. Nos. 80938, 108012).

Jalisco: Two miles east of Barra de Navidad (L.S.U.M.Z. No. 7880); Corcovado, 11 miles northeast of Autlán de Navarro (A.M.N.H. No. 102639); 9 to 11 miles northeast of La Huerta (A.M.N.H. Nos. 94643–94657; T.C.W.C. No. 24233).

Michoacán: Coahuayana (U.M.M.Z. No. 108011); Playa Azul (U.M.M.Z. Nos. 112523, 112524); Punta San Juan de Lima at Puerto de Tamarindo (U.M.M.Z. No. 108010).

In addition, two flattened, desiccated specimens, subsequently discarded, were collected at the edge of La Ciénega, a large swamp 6 miles southeast of Cihuatlán, Colima.

Identification

This southernmost race of *Natrix valida* is characterized by its usually brown or chocolate-brown coloration in life, by a light lateral area, hereinafter called a stripe, occupying the first two or three rows of dorsal scales on each side of the body, by the low number of ventral scutes, and by a slightly higher mean number of subcaudals.

The light lateral stripe is especially conspicuous and is in strongest contrast with the darker dorsal ground color in populations from Colima and adjacent Jalisco (pl. 9, fig. 7).

For purposes of comparison the numbers of ventrals and subcaudals in *isabelleae* and *valida* may be summarized as follows: (a) *isabelleae:* Ventrals in 20 males, 131 to 137, mean 134.0; in 37 females, 130 to 138, mean 133.7. Subcaudals in 12 males, 76 to 81,

[1] Reported as U.I.M.N.H. No. 28920 by Werler and Smith (1952, p. 564).

mean 78.3; in 30 females, 68 to 76, mean 72.4. (b) *valida:* Ventrals in 134 males, 136 to 150, mean 141.7; in 126 females, 132 to 147, mean 140.3. Subcaudals in 109 males, 70 to 86, mean 77.8; in 100 females, 61 to 78, mean 70.4.

The meristic differences are best demonstrated by subtracting the number of subcaudals from the number of ventrals in each individual specimen with a complete tail. The resulting figure (the remainder) among males of *isabelleae* is 58 or fewer in all (100%); among males of *valida* it is 59 or greater in 86.7 per cent of the specimens. The corresponding remainder among females of *isabelleae* is 65 or fewer in 100 per cent; among females of *valida* it is 66 or greater in 86.5 per cent. (See fig. 2 and chart 4.)

Scutellation

Scale counts in *isabelleae* may be summarized as follows: Ventrals in males, 131 to 137, mean 134.0; in females, 130 to 138, mean 133.7. Anal plate divided in all specimens. Subcaudals in males, 76 to 81, mean 78.3; in females, 68 to 76, mean 72.4.

The dorsal scale-row formula is normally 19–17, but there are a few increases to 20 or 21 rows. Among 20 males one has a count of 21; among 37 females three (8.2%) have counts of 21 and two (5.4%) have counts of 20. The minimum number of rows is 17 in all specimens, except in one female in which there is a reduction to 16.

Dorsal reductions among 10 males are:

19 3+4 (67–84)—*17* (132–136)

Scale reductions among 10 females are:

19 3+4 (64–83)—*17* (130–137)

Supralabials usually eight, in rare cases seven, and in very rare cases nine. Infralabials usually 10, rarely nine or 11. A single preocular and three postoculars in every specimen examined. Usually a single anterior temporal, but two in 6.5 per cent of the counts. Temporals in second row two (in 51.9% of the counts) or three (48.1%). Normally the fourth and fifth supralabials enter the eye; in one snake the fifth and sixth enter on one side of the head. In six counts the fourth and fifth scales are fused into a single scale, so that only the fourth supralabial enters the eye.

Coloration and Pattern

The dorsal view of the head, a lateral view at midbody, and a ventral view at midbody of the holotype, an adult female, are illustrated in color (pl. 2, fig. 1). Details of the coloration of the entire animal were included in the original description (Conant, 1953, pp. 8–9).

Among adults the coloration of the middorsal area varies from brown (Sepia to slightly darker than Mummy Brown) to reddish brown (Russet or Mars Brown). The lowermost two or three rows of scales are paler, and in many cases are in marked contrast to the ground color of the middorsal area; they vary from dull yellowish brown (Isabella Color) to Cinnamon-Brown. There are four rows of dark spots, each spot usually occupying only the anterior edges of any one scale. In general the dark spots are less conspicuous in *isabelleae* than in the subspecies *valida*, and they tend to fade toward the tail, often making it difficult or impossible to count the number in any one row. In fact, an accurate count of the spots could be made in only one male among the material available for study, and many of the males lack dark markings entirely (pl. 9, fig. 7). The venter is usually without markings and varies in coloration from dull yellow (Colonial Buff) to pale pinkish (Orient Pink).

The general coloration of an adult female from 9 miles southeast of Tecomán, Colima, and on which notes were made in the field, may be summarized as follows: Dorsal ground color, including top of head, milk-chocolate brown. Lateral stripe pale brown, with a slightly pinkish tinge, and in strong contrast to and abruptly separated from the darker brown of the back. Dorsal markings black or very dark brown. Supralabials pale brown, but darker than the lateral ground color. Chin, throat, and infralabials cream-colored, with a slightly pinkish brown tinge. Venter pale pinkish brown; under side of tail similar, but with a longitudinal dull gray area along the common sutures of the subcaudals. Eye: Pupil black, very narrowly ringed by dull orange; iris brown, nearly matching top of head. Tongue: Pink, dusted with black dorsally; tips and fork black.

The general coloration of an adult male

(pl. 9, fig. 7) from 9 miles northeast of La Huerta, Jalisco, may be summarized as follows: Dorsal coloration brown (slightly darker than Mummy Brown). Top of head Brownish Olive. Lateral stripe, occupying the lowermost two rows of scales and the lateral edges of the ventrals, Light Brownish Olive, and separated rather sharply from the darker brown of the back. Lateral stripe changing to dull yellowish brown (Isabella Color) on the sides of the neck, and the same color extends onto the supralabials. Infralabials Cream-Buff dusted with Isabella Color; throat Cream-Buff. Venter dull yellow (Colonial Buff), but strongly washed on the anterior three-fourths of each ventral with pale olive (Deep Olive-Buff). Anal plate pale purplish buff (Vinaceous-Buff). Under side of tail similar to belly, but more strongly washed with Deep Olive-Buff; posterior half washed with purplish buff (Avellaneous); a longitudinal dull gray area along the common sutures of the subcaudals. Eye: Pupil black, narrowly ringed in part with orange-yellow; iris medium brown (close to Dresden Brown). Tongue: Purplish pink stippled with black, especially on the dorsal surface; tips black.

In a young specimen, probably only a few weeks old, from 9 miles southeast of Tecomán, Colima, the coloration is similar to that of the female described above, from the same locality, except that it is paler and the lateral ground color contrasts less sharply with that of the middorsal region.

The number of dark spots in one of the lower rows varies in 10 females from 63 to 73, mean 66.5; it is 71 in the only male on which counts could be made.

Size and Sex

The 10 largest females have measurements as follows: Head-body length, 707 mm. (total length 847+ mm.); 624 mm. (841 mm.); 605 mm. (814 mm.); 605 mm. (807 mm.); 600 mm. (800 mm.); 580 mm. (786 mm.); 562 mm. (700+ mm.); 555 mm. (735+ mm.); 545 mm. (729 mm.); and 531 mm. (710 mm.). Comparable measurements for the 10 largest males are: 479 mm. (646+ mm.); 468 mm. (621+ mm.); 441 mm. (531+ mm.); 427 mm. (582+ mm.); 408 mm. (568 mm.); 398 mm. (529+ mm.); 396 mm. (546 mm.); 395 mm. (521+ mm.); 382 mm. (521 mm.); and 379 mm. (531 mm.).

No specimens of *isabelleae* were born in captivity, but several wild-caught individuals have total length measurements that fall within the range of variation of litters of young born to other subspecies. The smallest individual of *isabelleae* is an aberrant male measuring 181 mm. in total length from El Limoncito, Guerrero, on which Edward H. Taylor (1940, pp. 448–450) published notes and illustrations and on which I later commented (Conant, 1946, p. 258). Three juvenile females from La Huerta, Jalisco, vary in total length from 187 mm. to 203 mm. The smallest presumably normal male measures 226 mm.

Tail length/total length ratios for males of all sizes are 0.27–0.29 (0.275); for females, 0.24–0.27 (0.259).

Ecology and Natural History

During our field work we found *Natrix valida isabelleae* occurring in numbers in at least three areas: (1) in the valley northeast of La Huerta, Jalisco; (2) through the flat swampy lowlands of coastal Colima near Tecomán and near Cihuatlán; and (3) at the type locality, the Laguna Coyuca at Pie de La Cuesta northwest of Acapulco, Guerrero. Joe La Pointe (personal communication) also found it abundant in Colima, between Manzanillo and Cuyutlán, where he saw several dozen of these water snakes on the road during the course of field activities on the night of December 24, 1962.

Since suitable habitats for this taxon apparently occur at many places along the Pacific coast, these snakes probably are abundant in other areas, and any collector who directed his attention exclusively to the semiaquatic fauna might have little difficulty assembling series of specimens. Both James A. Peters and William E. Duellman found *isabelleae* along the Michoacán coast incidental to their general collecting activities via pack train during the early 1950's (Peters, 1960, pp. 329, 332), and their specimens remain the only ones extant from Michoacán.

Most of the localities (map 4) would fall within the narrow strip of thorn forest mapped by Leopold (MS), but others are

in the area occupied predominantly by tropical deciduous forest. Rainfall along the coast varies from 1050 mm. a year at Manzanillo, Colima, to 1503 mm. at Acapulco; at the more inland city of Colima it is 876 mm. There is a marked rainy season from June to October, inclusive, at all three stations. The mean and maximum (the latter in parentheses) recorded temperatures at the three localities are: Manzanillo, 26.1° C. (39.4° C.); Colima, 24.6° C. (40.5° C.); and Acapulco, 27.2° C. (36.3° C.). The climatological data are from Contreras Arias (1942).

The valley northeast of La Huerta, Jalisco, where we obtained 15 water snakes within a few hours, is fairly broad, relatively flat, and approximately 10 miles in length. Although it is included within the basin of the Río Purificación, it is poorly drained, and there are swampy areas and some standing water, at least during the rainy season. The most prominent such feature along the road (Mexico No. 80) is a large marshy area about 2 miles southwest of Los Tecomates that contained so much water on June 14, 1964, that James R. Dixon, during a visit to the area, described it as a lake (personal communication). It was much smaller at the time of our visit on July 21, 1965, and occupied only a broad flat area varying from 100 to 200 yards in width that was choked with water hyacinths, most of them stranded in shallow, stagnant, fetid water (pl. 20, fig. 1). From the general appearance of the habitat there obviously had been a much greater volume of water a short time previously. At least a dozen each of jacanas and gallinules were foraging among the plants (for small snakes as well as other food?). Directly across the road was a ditch with open water and small extensions that penetrated into the adjacent jungle of thorn trees. Many least grebes and some gallinules were active in or near the main ditch. Along the road in the direction of Los Tecomates were a number of broad, flat, wet areas, most of which were completely covered by hyacinths, and in these it also was obvious that the water level had recently dropped considerably.

During the late afternoon of July 21 there was a brief, but intense, thundershower, during and after which six specimens of *isabelleae* were killed by cars on the road opposite the "lake." After dark others ventured onto or across the road, and many additional ones were killed by passing vehicles although the traffic was very light. We presumed the shower may have been the initial stimulus to their activity, but hunger may have been a more important factor. The drop in water level apparently had concentrated the snakes, their food, and competitors for the food in a small area. The numbers of fishes and tadpoles were probably greatly reduced; I saw none while wading, and we heard only two frogs (*Smilisca baudini*) calling. A few frogs of the same species and of *Agalychnis dacnicolor* and *Rana pipiens* were on the road, but all were of large size and suitable as food only for some of the larger predators. Most of the water snakes were thin; one caught alive among the hyacinths could be best described as gaunt. It fed voraciously for weeks in captivity after our return to our home base. We collected a large number of *Leptodeira maculata* at the same time and place, and Dixon reported (personal communication) having collected numerous specimens of *Leptodeira* and *Drymobius* during his visit the previous year.

On the coastal plain we found *isabelleae* in several localities. Two were taken during the evening of August 24, 1961, in Colima near the Río Cihuatlán, one on the highway and another as it was swimming along the edge of an irrigation ditch. Two flattened, desiccated carcasses of specimens that had been mashed on the road, and were then dried and pushed or blown to the side, were found by careful searching through the sparse weeds at the edge of the highway where it skirts the edge of La Ciénega, an enormous swamp about 6 miles southeast of Cihuatlán. This deep swamp, which extends virtually to the ocean, is treeless but supports vast stretches of aquatic plants through which numerous small watercourses meander. Hundreds of wood ibises and many egrets were in evidence during the afternoon of July 22, 1965.

At night southeast of Tecomán, Colima, we found a small water snake in a concrete canal, and caught two others, including an

adult, in a muddy stream that was serving as a temporary outlet for a large drainage project that we were told would empty a small lake northeast of the road.

The Laguna Coyuca, at the eastern end of which the type series of *isabelleae* was collected, is perhaps typical of the many attenuated lagoons that are a characteristic feature of the narrow, intermittent coastal plain. Some idea of their size and frequency is evident through a perusal of the Ciudad de México sheet (American Geographical Society of New York, 1938). This map shows the Laguna Coyuca as contiguous at its western end with the Laguna Mitla, and with the two bodies of water extending for a distance of about 30 miles west-northwest from Pie de la Cuesta. Other more recent maps show the *lagunas* well separated, which may reflect the instability of the dune-fronted shoreline and the occasional cutting of new outlets to the sea or the damming of old ones.

According to natives at the *playa* at Pie de la Cuesta, the water is sometimes brackish, but it apparently was not during our visit to the locality on October 8 and 9, 1949. There were masses of floating water hyacinths and reeds; some of the latter were emergent and alive whereas others were recumbent, dead, and brown. The weather was hot and humid, and there was a heavy thundershower just before midnight on October 8. Five large adult water snakes and three juveniles were collected at night in shallow ponds at the edge of the lagoon. Three were found prowling at the surface in hyacinths, one small specimen was taken as it sought shelter under a rock at the water's edge, a very small juvenile was caught near a stone retaining wall, and the others (all adults) were on masses of dead tules that they closely resembled, both in coloration and thickness. The snakes in general were alert and active, and two or three others eluded us. The larger ones bit savagely and repeatedly.

The relative salinity of the Laguna Coyuca and the other coastal lagoons undoubtedly varies under the influence of such factors as rainfall, violent oceanic storms, spindrift, and the effects of inlets, depending on whether they are wide or narrow, always open or closed during part of the year, and whether the currents passing through them are sufficiently strong to change seriously the chloride content of the water in distant parts of a lagoon. Many of the lagoons are apparently cut off from the sea completely or are exposed to incursions of salt water only during great storms. Be that as it may, *isabelleae* occurs in at least several of these lagoons, and it may be present in all or most of those that offer fresh or slightly brackish habitats. Duellman (1961, p. 113) stated that the specimens "from Playa Azul were collected from a small brackish, mangrove-lined lagoon."

Captives fed readily on fishes and frogs. While they were being sustained in the field, they ate tadpoles of *Scaphiopus* and recently transformed *Bufo compactilis* as well as a wide variety of small fishes. No data are available on reproduction in this taxon.

Natrix valida thamnophisoides Conant

TEPIC WATER SNAKE

Plate 2, figure 3, plate 9, figures 5, 6

Natrix valida thamnophisoides CONANT, 1961, p. 2.

TYPE AND TYPE LOCALITY

A.M.N.H. No. 84091, holotype, an adult female collected July 3 or 4, 1959, along the Río San Cayetano (Río de Tepic on some maps and also known locally as the Río Mololoa) at Puente San Cayetano, approximately 3.5 miles southeast of Tepic, Nayarit, and at an elevation slightly above 3000 feet (914 meters).

RANGE

All known localities for this subspecies are in the drainage of the Río San Cayetano, a stream that passes through Tepic and is tributary to the Río Grande de Santiago, one of the major rivers of western Mexico. All are on an elevated outlier of the Mexican *altiplano* in a basin exhibiting only moderate relief but which is largely surrounded by mountains. The collecting stations vary from 3000 to 3350 feet (914 to 1021 meters) in altitude. Probably the geographical range is considerably greater, for intergradation between *thamnophisoides* and the subspecies *valida* has been demonstrated near Rosa-

morada, Nayarit (Conant, 1961, pp. 5, 8), and at least suggestions of pale middorsal stripes, the chief pattern characteristic of *thamnophisoides*, appear in a few specimens from localities east, west, and southwest of the vicinity of Tepic (see pp. 94–96 and also map 5).

The locality data and museum numbers for the 118 specimens studied in detail are as follows:

NAYARIT: Hacienda de García, 3.2 miles southeast of Tepic (A.M.N.H. Nos. 75751, 94612–94642); Puente de San Cayetano, 3.5 miles southeast of Tepic (A.M.N.H. Nos. 80593, 84091–84122, 88893–88901; A.N.S.P. Nos. 27211, 27212; C.A.S. Nos. 102397, 102398; C.M. Nos. 41668–41670; F.M.N.H. Nos. 154801, 154802; U.I.M.N.H. Nos. 63730, 63731); Tepic (A.M.N.H. No. 68539; F.M.N.H. Nos. 115617, 115618); 5.4 miles south-southeast of Tepic (U.M.M.Z. No. 126144); 14 miles southeast of Tepic (A.M.N.H. Nos. 84123–84150); 15.1 miles southeast of Tepic (U.A.Z. No. 14480).

IDENTIFICATION

Serpents of this taxon resemble typical garter snakes (*Thamnophis*) more closely than does any other form of *Natrix* indigenous to Mexico. The pale middorsal stripe, one scale in width, is usually well defined and is especially conspicuous when the snakes are submerged in water (or preservative). It is evident in the newborn young and soon becomes prominent, even among subadults of both sexes. It may be obscured, at least in part, however, when a snake is approaching ecdysis. The lowermost three rows of scales are noticeably pale in most specimens, and the over-all effect is of a striped snake with yellowish brown to pale brown longitudinal stripes on a ground color of darker brown.

The divided anal plate distinguishes this form from members of the genus *Thamnophis*, although one specimen of *thamnophisoides* among the 118 studied has a single anal plate. *Thamnophis eques* (subspecies?) occurs at the type locality (Puente San Cayetano) and probably other localities, and care must be taken in the field in making identifications, especially if the snakes are muddy or if their patterns are subdued prior to shedding. In the garter snake, however, the pale lateral stripe involves the fourth as well as the third row of scales, at least on the anterior part of the body. The pale area on the lower rows of scales does not extend upward onto the fourth row of scales in *thamnophisoides*.

SCUTELLATION

Scale counts in *thamnophisoides* may be summarized as follows: Ventrals in males, 130 to 140, mean 135.3; in females, 127 to 139, mean 133.6. The anal plate is divided in all specimens with one exception; it is single in an adult female from the Hacienda de García (A.M.N.H. No. 94616). Subcaudals in males, 69 to 80, mean 74.3; in females, 65 to 73, mean 68.7. Not included is an aberrant female with 81 subcaudals (see Conant, 1961, table 1).

The dorsal-scale formula is normally 19–17. The maximum number of scale rows is 19 with few exceptions; counts of 21 occur in one male among 57 specimens, and in seven females (11.1%) among 63 specimens. The minimum number of scale rows seldom deviates from 17; among the 57 males two have counts of 16 and one has 15, whereas the number is invariably 17 among 61 normal females. Two other females, both newborn, have highly irregular scale rows in the anal region, with the count dropping to 15 in one and 13 in the other. Counts from these two snakes, in which the scale rows are considered to be abnormal, are not included in table 6.

Dorsal-scale reductions among 10 males are:

19 3+4 (66–76)—*17* (132–139)

Scale reductions among 10 females are:

19 3+4 (64–81)—*17* (127–135)

In all seven of the females in which there are maxima of 21 rows there is an increase from 19 and a return to 19 through the addition or loss of paravertebral rows of scales. The increases to 21 occur at the level of the twenty-fourth to the fifty-sixth ventral, and the decreases from the level of the fifty-fourth to the eighty-ninth ventral. In most of these snakes 21 rows occur only for short distances; the counts vary from the longitudinal length of two scales to 48. In

one specimen (A.M.N.H. No. 94632) the increase to 21 occurs through the addition of a fourth and a paravertebral row of scales, both on the right side of the body.

Supralabials in most cases eight, but nine in 7 per cent of the counts, rarely seven. Infralabials in most cases 10, rarely nine or 11. Normally a single preocular, rarely two. In eight cases (3.3%) the preocular, although counted as a single scale, is grooved horizontally. Postoculars normally three, but two in 9 per cent of the counts, very rarely four. A single anterior temporal on both sides of the head in every specimen. Temporals in second row two in 54.4 per cent of the counts and three in 45.6 per cent. Normally two supralabials, the fourth and fifth, enter the eye, but the fifth and sixth enter in 12 cases (5%). Only a single scale, the fourth, enters the eye in two cases; three scales, the fourth, fifth, and sixth, enter in two other cases.

Coloration and Pattern

The dorsal view of the head, a lateral view at midbody, and a middorsal view at midbody of the holotype, an adult female, are illustrated in color (pl. 2, fig. 3). Details on the coloration of the entire animal were included in the original description (Conant, 1961, pp. 3–4).

Among adults the dorsal ground color varies from brown (Sepia) to brownish olive, but the two or three rows of scales lateral to the pale middorsal stripe are slightly darker (Dark Olive in some) than the remainder of the dorsum. The lowermost three rows and the lateral edges of the ventrals are paler; they vary from pale brown to light brownish olive. The middorsal stripe varies from medium brown or light olive to dull yellowish brown (Isabella Color). As in *valida*, the nominate form, the largest and most conspicuous dark dorsal spots are arranged in four longitudinal rows. The spots vary in size from one specimen to another, occupying, in some, the equivalent of a single dorsal scale, whereas in others they are small; in either case they are chiefly confined to the edges of the scales. As is the case among the newborn young described below, there is a tendency in some adult specimens for pigment slightly darker than the ground color to occur lineally between adjacent dark spots and thus to impart a suggestion of dark longitudinal stripes.

In many specimens the pale coloration of the skin between the scales may invade the edges of some of the dorsal scales to form short, pale yellow lines or curves (see pl. 2, fig. 3, lateral and dorsal views). The venter is usually pale yellowish, with or without some darkening posteriorly. In newborn juveniles the dorsal coloration is brown or brownish gray.

The general coloration of two adult males from Puente San Cayetano, 3.5 miles southeast of Tepic, Nayarit (the type locality), may be summarized as follows: Dorsal ground color Sepia, the three rows of scales flanking the pale middorsal stripe somewhat darker. Lateral ground color, involving the three lowermost rows of scales and the lateral tips of the ventrals, light brown (near Tawny-Olive). Middorsal stripe medium brown (Saccardo's Umber). Top of head brownish olive; supralabials light brown, the posterior borders of the third, fourth, fifth, and sixth ones narrowly edged with black, and the posterior edges of the other supralabials edged with gray. Infralabials similar in coloration, but with the maculations on the posterior edges of the scales gray or brownish gray and relatively inconspicuous. Gular region almost white. Venter pale yellowish, with virtually no darkening posteriorly. Under side of tail slightly darker and with a narrow dusky area down its center. Eye: Pupil black, very narrowly ringed with yellow; iris rich dark brown (Bister). Tongue: Pink at base, tips black; upper surface with a faint dusky stippling.

Notes on a litter of 22 young from the same locality were recorded on July 9, 1959, the day after the snakes were born and after all had shed their skins. The coloration and markings in these may be summarized as follows: Dorsal surface grayish brown, but varying from one individual to another; a few were darker and grayer and a few were slightly orange-brown. Middorsal stripe evident in all, but only slightly paler than the ground color. Lowermost two rows of scales (and lateral tips of ventrals) paler than remainder of dorsum and collectively constituting a lateral stripe that is paler than the middorsal stripe. Two rows of dark spots

on each side of body; upper row adjacent to and touching the pale middorsal stripe, and lower row adjacent to and touching the pale lateral stripe. Along the line of these two rows of spots the pigment on the scales is slightly darker than elsewhere on the dorsal ground color, producing, with the dark spots, the effect of four longitudinal dark stripes. Top of head medium dark brown; paired very pale parietal spots faintly evident. Venter, including under side of tail, pale brown, with a slight orange tinge. Eye: Pupil black, iris dark brown. Tongue: Base pink; tips black.

The pale middorsal stripe, extending the length of the body, is clearly evident in all specimens except two, both from Tepic. In one of these (A.M.N.H. No. 68539) the stripe is conspicuous on the neck but faint throughout the rest of its length. From the other (F.M.N.H. No. 115618) the stripe is virtually absent, although it can vaguely be detected when the animal is immersed in preservative. The stripe normally occupies the full width of the middorsal row of scales, but in many cases it involves the edges of the adjacent rows of scales, rarely as much as one-half of each.

Pale, paired, and slightly elongated spots along the common suture of the parietals are faintly evident in many of the newborn young, but they tend to disappear with age. Extremely faint suggestions of such spots, however, occur in some adults.

A review of color and pattern variations among the type series may be consulted for further details (Conant, 1961, pp. 4–5).

The number of dark spots in one of the lower rows varies in 10 males from 63 to 78, mean 72.9; in 10 females, from 64 to 76, mean 70.1.

Size and Sex

The 10 largest females have measurements as follows: Head-body length, 672 mm. (total length 842+ mm.); 603 mm. (683+ mm.); 592 mm. (756 mm.); 574 mm. (759 mm.); 542 mm. (713 mm.); 535 mm. (688+ mm.); 520 mm. (665+ mm.); 480 mm. (597+ mm.); 478 mm. (512+ mm.); and 476 mm. (577+ mm.). Comparable measurements for the 10 largest males are: 500 mm. (590+ mm.); 479 mm. (607+ mm.); 469 mm. (606+ mm.); 459 mm. (616 mm.); 443 mm. (536+ mm.); 440 mm. (590 mm.); 440 mm. (570+ mm.); 436 mm. (586 mm.); 435 mm. (538+ mm.); and 427 mm. (469+ mm.).

Among 46 captive-born young the total lengths varied from 165 mm. to 190 mm., and the means, calculated separately for the four litters involved, varied from 167.0 mm. to 182.4 mm. (table 21). The sex ratios among the newborn young were 24 males to 22 females, but there were marked imbalances among the litters, with 14 males to eight females in one litter and six females to two males in another. The smallest wild-caught specimen measured 211 mm. in total length.

Tail length/total length ratios for males of all sizes are 0.25–0.29 (0.264); for females, 0.24–0.27 (0.251).

Ecology and Natural History

All the localities southeast of Tepic are in areas of sparse thorn forest. There is a marked rainy season at Tepic, and most of the annual precipitation of 1197 mm. falls from June to September, inclusive, although there is also a minor peak during the winter months. The mean annual temperature is 20.9° C., and the highest temperature ever recorded was 38.9° C. Contreras Arias (1942), the source of these climatological data, characterized the climate at Tepic as warm and humid, with a dry spring and without a definite winter season.

We collected samples of *thamnophisoides* at three localities:

1. Puente de San Cayetano, about 3.5 miles southeast of Tepic, along the Río San Cayetano and in nearby meadows (1959, 1961, and 1965): The river at this locality presumably is dammed a short distance downstream from the point where the highway (Mexico No. 15) crosses it, for it is relatively wide during the rainy season and there is no rapid current even when it overflows its banks after heavy downpours (pl. 21, fig. 1). Two large females of *thamnophisoides*, collected during the sunny mid-morning of July 3, 1959, were coiled on the bank a short distance upstream from the bridge; one was in a dense clump of vegetation it had just entered by swimming from relatively deep water toward shore. Three others were taken

at night in the same general vicinity as they prowled in shallow water.

Directly west of the Río San Cayetano and extending southward from the highway for many hundred yards are grassy meadows containing numerous small springs and spring runs that apparently vary in volume and depth with the amount of rainfall. During our 1959 visit, when the water was high, several specimens of *thamnophisoides* and many *Thamnophis eques* ssp. were taken in the meadows, and frogs of several species were calling at night (July 2 and 3). On September 2, 1961, the water was much lower, and the runs were shallow and sluggish, and not over 30 inches deep in any place where we worked. Some of the deeper stretches were linked by short, shallow riffles over which the water flowed rapidly (pl. 21, fig. 3). Water snakes were found half submerged on four such riffles about midmorning, and three were caught. All were lying quietly in the miniature rapids, but were evidently alert to seize any fishes or tadpoles that passed. I carefully examined some of the riffles and saw several small fishes descending them; all were small and not more than ½ inch in length. The weather was clear, with an air temperature of about 30° C.

The water was low at this same locality on July 9, 1965. The runs through the meadows were dry except for stagnant pools and a slight amount of water that was flowing along the largest rill near the highway. There were a few shallow, muddy pools close to the river, which was completely confined to its channel. We arrived at 9:30 A.M., and the snakes apparently were just emerging from shelter for the day. Several were found sunning on banks rising about a meter above the pools or stretched out in low, shrubby, catclaw bushes close to the edge of the banks; others were at the water's edge. Cloacal temperatures and corresponding water temperatures (the latter in parentheses) were recorded for three specimens: 28.8° C. (29.2° C.); 28.2° C. (28.0° C.); and 32.8° C. (basking away from the water).

2. Along an arm of the Río San Cayetano near the Hacienda de García, about 3.2 miles southeast of Tepic (1961): A large series was collected at this locality on September 2, 1961, and the following observations are condensed from my field notes: "Hunting began immediately after dark. The arm of the river at this point is broad and shallow and bordered along the shore in part by floating mats of water hyacinths, but it also has some sandy beaches with a minimum of vegetation, much of it algae, to serve as hiding places. As I approached, dozens of small fishes were jumping out of the water presumably in an effort to avoid the circle of light from my headlamp. Almost at once I saw a *Natrix*, and within an hour and a half had collected 29, which, judging from the large numbers seen, represented only a fraction of those present. All were actively hunting, apparently stimulated by the swarms of small fishes. They swam at the surface with their mouths open and grabbed at any moving objects, including a small, floating, bulbous piece of hyacinth, and at the silvery reflections from the wavelets stirred up by my boots as the light struck the gently bobbing surface of the water. At one time three *Natrix* were in sight at once, and there often were two. Native boys with us stated that swarms of fishes are unusual at this locality."

Several of the snakes disgorged fishes into the collecting bag, and these were later identified by Robert Rush Miller as *Poecilia mexicana* Steindachner. Many individuals of *Rana megapoda* were also actively feeding in the shallow water. Data recorded at 8:30 P.M. were: air temperature, 21.3° C.; water temperature, 23.0° C.; cloacal temperature of one water snake, 23.8° C.; pH of water, 5.5; elevation, about 3000 feet.

3. Along a tributary of the Río San Cayetano about 14 miles southeast of Tepic (1959): This locality consisted of a small, gently flowing stream in a large open valley near the extinct volcano Sangangüey. During our visit on July 7, 1959, it varied from 10 to 20 feet in width and apparently did not exceed 4 feet in depth. The banks were of mud and chiefly steep-sided, with an average drop of 4 feet to the water, but they had caved in at several places to form short, shallow interruptions in the generally deeper streambed, and at these places there was some emergent vegetation. Thorny trees grew along the bank, and there were several places

where large mats of water hyacinths, especially downstream from the highway bridge (Mexico No. 15), completely covered the surface. During late morning the weather was cool, overcast, and threatening rain, but there was occasional weak sunshine. Six snakes were seen basking among piles of thorns and weeds overhanging the water, but only two were caught. We returned to the locality shortly after dark and just before a torrential downpour of a half hour's duration. This stimulated a large mixed chorus of frogs in an area of shallow water paralleling the road, which had been turned temporarily into a pond, and the calls of *Pternohyla fodiens*, *Hyla eximia*, *Hyla smithi*, *Leptodactylus melanonotus*, and a *Hypopachus* (probably *oxyrrhinus ovis*) were recognized. The run-off from the "pond" was very rapid, and in two places erosion resulted in drop-offs of about a foot each, and these were occupied by miniature waterfalls. Near these, four individuals of *thamnophisoides* were found, which had apparently been stimulated by the hard rain and rapid current into exploring the temporary tributary of the stream.

Other snakes were taken along the stream itself after the rain, all prowling at the edge of the water. One on the opposite bank was kept under observation for more than five minutes as it moved against the current. In the shallows, where there were numerous plants to serve as shelters or anchor points for crawling, its progress was slow and deliberate, but, when it arrived at an open place where the banks were steep and bare, it swam swiftly until it attained the next patch of vegetation, whereupon it slowed down again. Eventually the snake swam rapidly across the stream and made a landfall 10 feet ahead of me where it was easily caught. Had it been attracted by the light? Similar behavior exhibited by many species of both *Natrix* and *Thamnophis* suggests they are attracted toward movements of light at night that may resemble the flash of a fish as its body approaches or breaks through the surface of the water.

All specimens found during daylight hours blended with their surroundings to a remarkable degree, the ground color matching the mud and the pale middorsal stripe resembling a partly desiccated blade of grass or tendril of a vine. The stripe was less prominent in individuals that were approaching ecdysis. These water snakes strongly resemble garter snakes. Eighteen specimens of *Thamnophis eques* ssp. were also collected in the meadows along the San Cayetano during our 1959 visit, and it was sometimes difficult to distinguish between the two species without making a close examination. All the garter snakes were collected by day and none was along the river proper (Conant, 1961, p. 12). No individual of *T. eques* was seen during our two later visits (in 1961 and 1965), when, as noted above, the spring runs were either dry or shallow and sluggish. A large specimen of *Thamnophis melanogaster canescens* was caught as it crawled across an open mud flat close to the river about noon on September 2, 1961. Garter snakes were conspicuously absent during the remainder of our field work within the range of *thamnophisoides*.

The physical condition of the specimens varied considerably. All 29 of those collected at night while they were feeding on the swarm of small fishes near the Hacienda de García were plump and seemed to be in excellent condition. One gave birth to eight young three weeks later. The snakes from 14 miles southeast of Tepic were also in good condition, with two exceptions; one was emaciated and lethargic, and the other, a female, was shrunken along the sides of the body and evidently had borne young recently. Two others collected at the same time and place gave birth to young in captivity (table 21). Two large females taken near the Puente de San Cayetano in 1959 were also thin and had shrunken sides, suggesting the recent birth of young; another was pregnant; almost all the others found at the same time and place were thin. Most of those collected in 1965 had infestations of parasites; these produced readily visible, lumpy swellings in the body walls of some of the snakes.

An adult captured at night disgorged what appeared to be an annelid worm. A partially digested fish removed from the stomach of a large individual of *thamnophisoides* (A.M.N.H. No. 68539) collected at Tepic was identified by Robert Rush Miller

as a member of the genus *Cichlasoma*. Captive specimens fed readily on small fishes, small hylid frogs, and *Rana pipiens*.

Data on reproduction are presented in table 21. The wide range (early July to late September) in dates of birth may indicate a long breeding season or suggest that some females may produce two litters of young in a single year, a phenomenon that has been reported for *Thamnophis proximus diabolicus* (Conant, 1965b, pp. 140–141).

The incidence of incomplete tails is exceptionally high in *thamnophisoides* in comparison with population samples of other races of *Natrix valida*. Among 25 snakes collected at the Puente de San Cayetano 14 have abbreviated tails; among 33 from the Hacienda de García 26 have incomplete tails; among 13 from 14 miles southeast of Tepic three have shortened tails. Some of the snakes in all three series have only stubs remaining. Among possible enemies both herons and turtles are chiefly suspect. Egrets were foraging in the meadows during our 1959 visit, and *Kinosternon integrum* was much in evidence both along the river and in the meadows, and many were trapped or caught by hand.

Natrix valida celaeno (Cope)

CAPE WATER SNAKE

Plate 2, figure 4, plate 10, figures 1–4

Tropidonotus celaeno COPE, 1860, p. 341.
Tropidonotus tephropleura COPE, 1860, p. 341.
Natrix valida celaeno: COPE, 1892, p. 670.

TYPE AND TYPE LOCALITY

U.S.N.M. No. 5281a, holotype, a female of medium size "discovered by Mr. John Xantus, at Cape St. Lucas, Lower California" (Cope, 1860, p. 341).

Cope, in his description, mentioned only a single specimen designated as "Smithsonian Institute" No. 351. The United States National Museum, has, however, seven additional specimens that bear the same collecting data (U.S.N.M. Nos. 5281b–5281g and 131748, the last of which was formerly a part of the No. 5281 series). There are also two others in the Academy of Natural Sciences of Philadelphia (A.N.S.P. Nos. 6643, 6644) that were originally part of the same series. All these snakes, at both institutions, were designated for many years as cotypes (=syntypes). The fact that two, one in each collection, have nearly identical scale counts was mentioned in an earlier paper (Conant, 1946, p. 262). Although I accepted U.S.N.M. No. 5281a as the holotype, it appeared desirable to make a direct comparison between the two specimens, which I have done recently through the courtesy of Dr. James A. Peters and Mr. Edmond V. Malnate.

The two snakes (U.S.N.M. No. 5281a and A.N.S.P. No. 6644), hereinafter called the "National Museum specimen" and the "Academy specimen," respectively, differ considerably in size, but Cope gave no measurements. Both have the same number of subcaudals, labials, preoculars, anterior temporals, and presumably the same number of ventrals (it is not certain where Cope began his ventral counts). I can now confirm, however, that the National Museum specimen is the holotype for the following reasons:

1. Cope (*loc. cit.*) stated "three preoculars." There are three on both sides of the head in the National Museum specimen; in the Academy specimen there are three postoculars on the left, but on the right the uppermost postocular is fused with the supraocular, on abnormality that occurs with some frequency among populations of *celaeno* (see p. 119).

2. The anterior temporal in the Academy specimen is greatly elongated as a result of the complete fusing of the first temporal with the lower temporal of the second row on both sides of the head. Cope in all probability would have called attention to this anomaly if he had closely examined the specimen.

3. After mentioning the first temporal, Cope wrote "remaining temporals four on each side." If all the scales lying between the labials and the parietal are counted (with the exception of the anterior temporal), there are four on each side of the head in the National Museum specimen but only three in the Academy specimen.

See Conant (1946, p. 262) for other information on the holotype and comments on the additional specimens bearing the same collecting data.

The type of *Tropidonotus tephropleura*, the

principal synonym of *celaeno*, cannot be found. Cope (1860, p. 341) based his description on two specimens in the Smithsonian Institution (numbers "4681 *type*, and 4680") from "Cape St. Lucas, in Lower California, by Mr. John Xantus." The United States National Museum has a series of six specimens (U.S.N.M. Nos. 4683a–4683f) designated as "syntypes" of *tephropleura*, and the Academy of Natural Sciences of Philadelphia has two others (A.N.S.P. Nos. 6641, 6642) which also bear paper tags with "4683" on them and apparently were originally part of the same series. All eight of these specimens are designated as from "Cape St. Lucas" and are attributed to Xántus, but none agrees either in pattern or in details of scutellation with Cope's description of *tephropleura*.

Comments on Type Locality

"Cape St. Lucas," which appears frequently in the literature as the type locality for many of the species received from Xántus, must be viewed with caution. Considerable evidence indicates it refers, at least in many cases, to the general area of the southern tip of Baja California and not necessarily to the vicinity of the chain of rocks jutting into the Pacific Ocean that has long borne the designation of "Cape St. Lucas" (=Cabo San Lucas). First, there is Xántus' own description of the place where he established a tidal station for the United States Coastal Survey and which served as his headquarters from April, 1859, until August, 1861: "The whole shore is sand for about ¼ of a mile, & then commences a cactus desert about 6 miles deep, which is again girded on the Pacific side & north side by mountains of 5 & 6000′ hight. . . . There is not a single tree for many miles, if we except the Cactuses, of which there is infinite variety. . . . The whole ground for miles is covered with saline effervescence, which makes painful to look for the eyes, and extremely difficult to walk on, as you sink in like deep sand" (Madden, 1949, p. 107).

This habitat was scarcely suitable for a water snake, and the area, except for the addition of a few shacks at the landward end of the chain of rocks, was virtually the same when we visited the locality on September 16, 1961. There is now a cannery nearby, and a small village, supported by modern wells, has been established a short distance inland. Xántus obtained his water by having it carried in goatskins for a distance of 7 miles from the brackish well of Thomas Ritchie, an English settler.

Madden (1949), in his scholarly and well-researched biography of János Xántus, pointed out (pp. 108–109) that Xántus ranged widely through the Cape Region during his collecting activities, but, excluding a visit to La Paz and Mazatlán, he "was never more than seventy-five miles, as the crow flies, from his station."

In an earlier study of the *Natrix valida* complex, I accepted Cabo San Lucas as the type locality for *celaeno* (Conant, 1946, pp. 261–262, 268), an action that, subsequent to our inspection of the area in 1961, I realized was untenable. Several other herpetologists, who apparently were equally unacquainted with the local geography, also accepted Cabo San Lucas as the type locality although the types of the species they were studying did not come from there. *Lichanura trivirgata* may be used as an example. In the original description Cope (1861, p. 304) stated that this boid "inhabits the southern region of Lower California, where Mr. J. Xantus . . . found it in swamps among the mountains." The nearest sizable mountains are about 12 miles north of Cabo San Lucas, but it is probable that the type of *trivirgata* came from much farther north, for Xántus collected, according to Madden (1949, p. 108), in the Sierras de San Lázaro, Santiago, and Santa Gertrudis. Nonetheless the type locality for *L. trivirgata* was given as "Cape St. Lucas" by Stejneger and Barbour (1917, p. 73, and in all subsequent editions of their check list), Smith and Taylor (1945, p. 26), and Klauber (1931, pp. 310, 314). Klauber (p. 306) also plotted his "Cape San Lucas" locality at the extreme southern tip of the Baja California peninsula, as I did for *Natrix* (Conant, 1946, fig. 2). Schmidt (1922, p. 683) listed "Cape St. Lucas" as a specific locality, but Stull (1935, p. 408), possibly because she compared Cope's statement with a topographical map of the region, avoided the same error by giving the type locality as "Southern Lower California."

The conservative approach is to consider "Cape St. Lucas" as a broad designation covering a considerable portion of the Cape Region of Baja California and not as a specific locality. Such is certainly the case in regard to both *celaeno* and its synonym *tephropleura*, and it probably also is true for many of the other species that have been based on material collected by Xántus in the general region. As Madden (1949, p. 129) pointed out, "Students of the Xántus collections, and particularly of his type specimens, have always been obliged to proceed with extreme caution because of the inaccuracy or untrustworthiness of his labels."

This statement of Madden's, however, does not agree with Cochran's (1961, p. ix) who wrote that "Xantus' material from Mexico is worthy of mention for the care he took in numbering every specimen and entering the locality for each number in one of his numerous letters to officials at the Smithsonian."

Madden's biography of Xántus, which is impersonal and even friendly in many instances, points out repeatedly that Xántus, besides being an indefatigable collector, was a monumental prevaricator and plagiarist who all too frequently embellished the truth in his attempts to be dramatic and to aggrandize his own accomplishments. He also, perhaps carelessly, placed the incorrect locality data on at least part of the material he shipped to Washington. In commenting on the untrustworthiness of some of the Xántus information, Madden (1949, p. 129) wrote: "In this connection, the association, never made public, which he [Xántus] had with Ferdinand Gruber, the San Francisco taxidermist, was to give rise to ornithological puzzles. Species of birds which have never otherwise been reported from Lower California, but marked with Cape district localities, were sent by Xántus to Baird. These birds are now known to be all of Upper California, and the hand of Gruber in their provenance has been suspected on the basis of taxidermal peculiarities attributable to him."

Under the circumstances it is prudent, as Miller and Hubbs (1954, pp. 234–235) strongly implied, for any investigator to be suspicious of Xántus' localities and to accept them only if they are substantiated by other material from the same places or their immediate vicinities. It can at least be stated with confidence that the type locality for *celaeno* was not Xántus' tidal station. Cochran (1961, p. 222), who may have obtained her information from one of the letters she mentioned (p. ix in the same paper), stated that the series of specimens, of which the type is a member, was from the "San José River, Cape San Lucas, Baja California, Mexico, J. Xantus, May 15, 1859." This, at least, is a much more likely locality, for other specimens of *Natrix* have been taken there. If the date and locality are correct, they would indicate that Xántus obtained these shortly after his arrival at Cabo San Lucas and during one of the occasional visits he made to San José del Cabo (Madden, 1949, p. 108). The snakes of the entire type series are dark, however, suggesting that they may have been collected at a more inland locality (see discussion below).

Taxonomic Considerations

The absence of a precise type locality makes it difficult to interpret the marked pattern differences that are manifest among the snakes of this complex from Baja California. The problem, succinctly stated, is: Are there two races of *Natrix valida* in the Cape Region or only one? The answer is not at hand, but it is instructive to review the available evidence.

In a previous study of the subspecies of *valida*, I attempted to sort the snakes from the area into four pattern groups (Conant, 1946, pp. 266–267), as follows:

Group A: Specimens very similar in appearance to typical members of the subspecies *valida* from mainland Mexico, with four rows of small black or dark brown spots on a dorsal ground color of pale gray or brown.

Group B: Similar to group A but with the dark markings larger and more pronounced.

Group C: Dark snakes with black heads; dorsal surface dark but with at least indications of large dark spots; a ragged pale lateral stripe involving the first three rows of scales.

Group D: Dark snakes, almost uniformly black or dark brown above, except for a pale lateral stripe as in group C.

Personal experience in the field in Baja California, near Agua Caliente and at Boca

de la Sierra, in addition to the examination of a number of other specimens recently collected by others, strongly indicates there is so much overlapping between pattern types C and D that the material of these two groups should be combined. Snakes displaying such dark coloration are hereinafter designated as Dark Populations.

Further, the acquisition of large numbers of the nominate form (*valida* from mainland Mexico) indicates that the intensity of spotting is so variable that it is expedient to combine Baja snakes of groups A and B. These hereinafter are designated as Pale Populations in reference to the pale tones of the dorsal ground color.

In general, among the snakes of undoubted provenance, the Dark Populations are from inland and slightly more upland localities, whereas the Pale Populations are from the lowlands and near the coast. If a precise type locality were available and if it were not for a number of anomalies and discrepancies, it might be possible to regard the Dark and Pale Populations as distinct subspecies.

The snakes of the type series (U.S.N.M. Nos. 5281a–5281g, 131748, and A.N.S.P. Nos. 6643, 6644) from the indefinite type locality of "Cape St. Lucas" all clearly belong to the Dark Populations, although they are rather faded after a century of preservation. If at least some of them came from the Río San José, as Cochran (1961, p. 222) indicated, they would then be from a lowland, coastal locality, which would be at variance with the distribution of the more recently collected material. There are also two anomalous specimens on which I have commented previously (Conant, 1946, p. 251): (1) U.S.N.M. No. 37545 collected by Nelson and Goldman at San José del Cabo, "in which the head is dark (probably black originally), the dorsum uniform brown, and the lateral stripe only very faintly defined"; and (2) U.S.N.M. No. 12642e collected in the Río San José by Belding, "with a dark head, which would place it in Group C or D, and a conspicuously spotted body, which would classify it as a member of Group B." These two snakes are thus intermediate between the Pale Populations and the Dark Populations.

Snakes of both pattern types have been collected at two localities (map 6). Among 53 specimens from Agua Caliente 47 are Dark and six are Pale; in addition all 12 snakes that I collected at the Presa El Chorro about 2 miles inland from Agua Caliente are Dark. Among three specimens from Santiago one is Dark, one is Pale, and the third is so badly faded that it cannot be assigned.

A comparison of the scutellation of the two groups yields virtually nothing to support the differences in coloration and pattern (table 17).

It is obvious that considerably more material will be needed before the taxonomic problem can be resolved. Of particular interest would be more specimens to shed light on the present status and the degree of variation in snakes from the Río San José in the vicinity of San José del Cabo, a locality from which both Pale and intermediate specimens are available. Considerable fresh material from Agua Caliente, Boca de La Sierra, and the nearby Arroyo San Bernardo, all of it Dark, is now at hand for study, but the higher elevations, which must be negotiated by pack train or on foot, should be explored, especially their western and southern slopes. At present there is only one record from the western side of the Cape Mountains (from 11 miles east-northeast of Todos Santos), which doubtless reflects the general inaccessibility of the region and the relative infrequency with which naturalists have worked there. Most collecting expeditions to the Cape Region, at least during recent years, have been brief and confined more or less to the loop road, a rough, unimproved track that is little more than a goat trail in many places and turns into a quagmire during and after the infrequent rains. Most field parties have followed the loop southward on the eastern side of the mountains, then westward from San José del Cabo to Cabo San Lucas, and returned northward along the Pacific coast through Todos Santos. Collectively they have contributed much to an understanding of this primitive region, but a herpetologically oriented naturalist, equipped to visit some of the more remote localities and who could afford to spend six months or a year in the area, could add im-

TABLE 17

COMPARISON OF CHARACTERS IN DARK AND PALE POPULATIONS OF *Natrix valida celaeno*

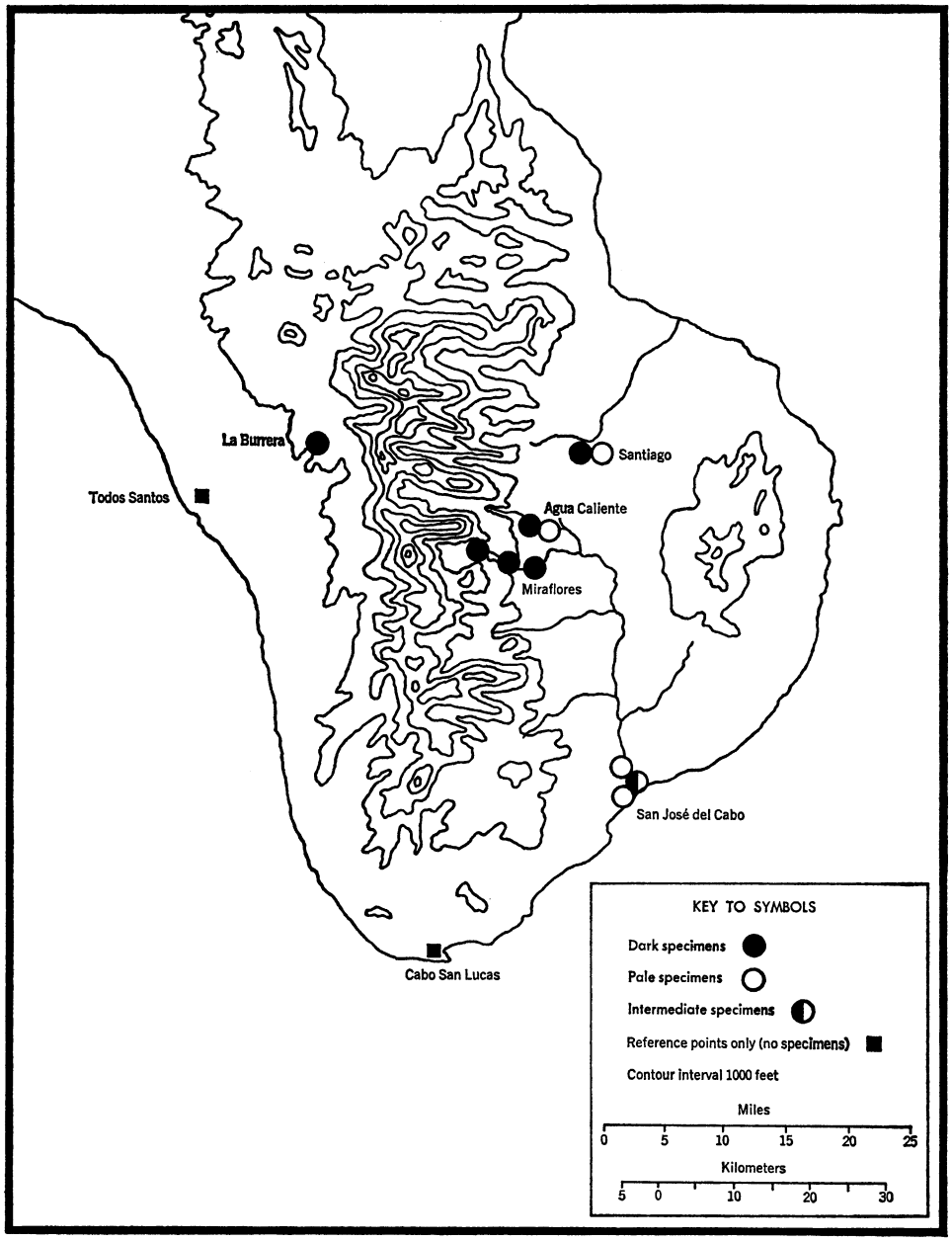
	Ventrals	Subcaudals	Ventrals Minus Subcaudals	Tail/Total
Dark males				
N	48	38	37	40
Mean	142.4	77.9	64.6	26.0
O.R.	140–146	74–82	60–70	24–28
Pale males				
N	10	10	10	10
Mean	140.6	78.5	64.0	26.4
O.R.	135–144	75–81	57–70	25–28
Dark females				
N	48	42	42	43
Mean	141.2	71.0	70.2	24.6
O.R.	138–145	67–75	66–76	23–26
Pale females				
N	16	11	11	11
Mean	140.6	70.7	70.9	25.1
O.R.	137–143	67–75	63–77	24–26

measurably to our knowledge of the reptiles and the few amphibians. Aside from offering clues on the taxonomic problem, valuable information would also accrue on the range, altitudinal limits, ecology, and natural history of *Natrix valida celaeno*.

Until more material is acquired and because of the problems concerning some of the locality data now available, it seems advisable to be conservative and to lump all Baja California material under the subspecies *celaeno*.

Future collecting may demonstrate whether the distribution of the two phenotypes forms a definite geographical pattern with (1) Dark specimens confined to inland localities and the mouths of arroyos discharging from the highlands, and (2) Pale specimens distributed only in the lowlands. Also pertinent to the problem is whether intermediate specimens occur where the two pattern types come together or whether they appear only at scattered localities.

It is probable that the Dark Populations have developed in isolation in the Cape Region. Whether the Pale Populations are relict from a much wider distribution, such as is postulated on page 118, or whether they arrived in Baja California at a relatively recent date is unknown. The chances that *valida* reached the peninsula across the Gulf of California under its own power are extremely remote (Conant, 1946, p. 270), but another possibility should be mentioned. That would be the accidental introduction of mainland *valida* by man at or near San José del Cabo, which has long been the center of the relatively infrequent coastwise commerce conducted near the extreme southern tip of the peninsula. Snakes of the subspecies *valida* are abundant near Mazatlán and doubtless many other mainland ports, and they could easily hide in produce or other commodities awaiting transport across the Gulf. If such an introduction took place, it might have been followed by a subsequent dispersal northward along the Río San José and, during the rare seasons of relatively heavy rainfall, into other watersheds farther north. Such a theory is scarcely tenable, however, for the length of time required for a northward dispersal and for the development of scale and pattern characteristics that are different (although in minor degree) from the norm of mainland *valida* would probably have been greater than the relatively short period of human occupancy of the Cape Region.



MAP 6. Locality records for *Natrix valida celaeno* in the Cape Region of Baja California.

RANGE

Streams, springs, and other bodies of water of the Cape Region of Baja California (Territorio Sur de Baja California). The Cape Region, as defined by Leviton and Banta (1964, p. 129), includes all the land mass lying east and south of a line drawn from La Paz to Todos Santos. This is not the same as the Cape District of Nelson (1922, pl. 31), which extended northward to Santa Rosalía, or the San Lucan Region as variously defined by other authors.

All records to date are either from relatively low elevations in the uplands of the Cape Region or from localities farther east and south (map 6). This water snake is un-

known from La Paz, although Yarrow (1882, p. 133) credited five specimens (U.S.N.M. No. 12642) collected by L. Belding to that locality. Van Denburgh (1922, p. 787) pointed out that these snakes actually are from the Río San José, according to Belding's own "MS."

Neil Richmond (personal communication) was told about "black snakes" in irrigation canals near La Purísima during an expedition to Baja California in 1961. Since he had recently caught a number of blackish specimens of *valida* at and near Boca de La Sierra, he made a special effort to investigate the report, but all he found were two small brown specimens of *Thamnophis digueti*. The only *digueti* that I have examined personally (C.A.S. No. 90606 from the Arroyo Santo Domingo) was a dark brown adult that probably would have appeared black under field conditions, so the report may have been based on that species. In any event, the presence of *Natrix valida* north of the central massif of the Cape Region remains to be demonstrated.

It is probable that the range of *celaeno* has shrunk somewhat in size during at least the past half century as a result of the manipulation of streams and the utilization of their water for human activities. At least one early collector obtained a small series of specimens from the Río San José, which flows southward to the town of the same name across the arid and dissected plain east of the high mountains, and some of the material labeled as San José del Cabo may have come from the same intermittent stream. Van Denburgh (1896, p. 153) stated, "It appears to be the most abundant snake of the country immediately surrounding San José del Cabo." Cope (1861, p. 298) remarked that "According to Mr. Xantus they are most common in swampy meadows among long grass." Despite the apparent former abundance of these snakes in the vicinity of San José del Cabo, there is only one record (N.H.S.S.D. No. 17655, collected October 30, 1941, about a mile southwest of San José del Cabo) more recent than 1929 from that general area. Alterations to the natural habitat presumably have reduced or even extirpated some of the local populations. In contrast, several collectors have demonstrated during the past decade that *celaeno* is still abundant in the foothills of the mountains in streams discharging eastward, and it probably remains "by far the most common snake in the upland country near Agua Caliente," a statement made many years ago by the late Joseph R. Slevin (in personal correspondence) on the basis of his field work in the area during 1919.

The altitudinal distribution, based on the several locality records, ranges from close to sea level at San José del Cabo to approximately 1640 feet in the Arroyo San Bernardo. Richmond (Fox, 1963, pp. 181, 184) ascended the latter to a much higher elevation, but he found no specimens of *celaeno* despite the fact that the habitat conditions (personal correspondence) appeared to be identical with those observed farther down the arroyo. The elevations listed in my early paper on *Natrix valida* (Conant, 1946, p. 268) are incorrect. They were taken from the Baja California-Sur sheet (American Geographical Society of New York, 1923) on which the contours are indicated as broken lines indicating approximations. The high figures shown on that map do not agree with elevations extrapolated from more recent maps such as sheet No. 24 (12Q-II) of "La carta geográfica de la República Mexicana" (Ex-Comisión Intersecretarial, 1958) and the map in Leviton and Banta (1964, fig. 1). The inescapable conclusion is that the area has not been adequately surveyed and that all the maps examined merely show approximations. The maximum elevation of 500 meters (1640 feet) was recorded on Richmond's altimeter. Our instrument registered 600 feet (183 meters) at Agua Caliente and 900 feet (274 meters) at Boca de La Sierra. Gerhard and Gulick (1958, p. 154) gave an elevation of 450 feet (137 meters) for Santiago. The difficulty of keeping altimeters properly calibrated in the field without known elevations on which to make daily checks points to the certainty that all these figures will be subject to revision when the Cape Region is better mapped.

No discussion of the range of *celaeno* would be complete without some mention of the relict position it occupies in relation to the mainland distribution of *Natrix valida*. A number of other organisms have similarly

disjunct ranges, with the same species occurring on both sides of the Gulf of California. Two are reptiles: (1) *Pseudemys scripta*, with the subspecies *nebulosa* in southern Baja and several other races on the mainland; and (2) *Ctenosaura hemilopha*. In both cases, however, possible introduction by human agency cannot be ruled out, inasmuch as turtles and large lizards are widely used as food.

No theoretical crossings of the Gulf need to be postulated (see discussion in Conant, 1946, pp. 270–271). A more logical explanation for these disjunct distributions is to assume that representatives of all three of the genera, *Natrix*, *Pseudemys*, and *Ctenosaura*, at one time occurred continuously around the head of the Gulf and that the increasing desiccation of the region during the post-glacial climatic deterioration caused a southward displacement in range, with the populations on the peninsula remaining trapped as relicts toward its southern end. Many reptiles and amphibians have present-day distributions that closely approximate the presumed former ranges of those species that are now disjunct. Bogert and Oliver (1945, table 1) listed no fewer than 35 (full) species that occur not only in both Sonora and Baja California but are also found above or near the head of the Gulf in either California or Arizona, or both. They included *Scaphiopus couchi* in their list, but Zweifel (1956a, pp. 33–34) cautioned that "the presence of *couchi* at the head of the Gulf of California remains to be verified by specimens." The deficiency has now been remedied by Mayhew (1962, p. 154) and Tinkham (1962, p. 204), both of whom reported this spadefoot from southeastern California.

A number of endemic forms generically or specifically differentiated from their nearest relatives also occur in the southern part of the peninsula (see Savage, 1960, table 4). The survival of relict taxa in southward-projecting peninsulas was discussed by Schmidt (1943, p. 249). Savage (1960, p. 205) theorized that *Natrix* may have entered Baja California during the Miocene.

The locality data and museum numbers for the 135 specimens studied in detail are as follows:

TERRITORIO SUR DE BAJA CALIFORNIA: "Cape St. Lucas," which should be interpreted as from the Cape Region and not as a specific locality, in accordance with the discussion above (A.N.S.P. Nos. 6641–6644; U.S.N.M. Nos. 4683a–4683f, 5281a–5281g, 131748); Agua Caliente (C.A.S. Nos. 45890–45923, 45925–45939; M.C.Z. No. 13160; M.V.Z. Nos. 11909–11911); 2 miles west of Agua Caliente at the Presa El Chorro (A.M.N.H. Nos. 94600–94611); Arroyo San Bernardo, between Boca de la Sierra and Rancho San Bernardo (C.M. Nos. 38290–38292, 38317–38319); Boca de la Sierra (A.M.N.H. Nos. 87581–87583, 101363; C.A.S. No. 91459; C.M. Nos. 38365, 38366, 38391–38395); Miraflores (A.M.N.H. No. 5605; C.A.S. Nos. 45940, 45941; F.M.N.H. Nos. 25873–25875; K.U. Nos. 78907–78910); Rancho La Burrera, 11 miles east-northeast of Todos Santos (N.H.S.S.D. No. 45200); Río San José, reported in error from La Paz (see p. 117) (U.S.N.M. Nos. 12642a–12642e); San José del Cabo (A.M.N.H. Nos. 5573, 5583; C.A.S. Nos. 45944, 45945; M.C.Z. No. 6818; M.V.Z. Nos. 11907, 11908; S.M.F. No. 21449; U.S.N.M. Nos. 37545, 56181, 56182, 64582); 1 mile southwest of San José del Cabo (N.H.S.S.D. No. 17655); Santiago (C.A.S. Nos. 45942, 45943; U.S.N.M. No. 131749).

IDENTIFICATION

The combination of a divided anal plate, strongly keeled scales, and a habitat in or near water is sufficient to identify snakes of this taxon in the field, for no other member of the genus is indigenous to Baja California.

The Cape water snake occurs in two pattern phases, which may be summarized as follows:

1. DARK PHASE: Dorsum uniformly black or very dark brown, but with indications in many specimens of large, poorly defined, dark blotches, each involving four or more scales. A pale longitudinal gray or olive stripe, with irregular upper and lower edges that involves the first to third rows of scales. A pale spot on the sixth supralabial. Belly virtually uniformly black or very dark brown. (See pl. 2, fig. 4, and pl. 10, figs. 1–4.)

2. PALE PHASE: Indistinguishable from mainland *valida*. Dorsum virtually uniform pale gray or brown or marked with numerous usually small but in some cases conspicuous black spots that are normally arranged in four longitudinal rows.

Each spot confined to the edges of one scale or also involving the edges of adjacent scales. Belly whitish or yellowish and virtually unmarked. (See illustrations of the subspecies *valida*, pl. 9, figs. 1–4, for general appearance of snakes of this phase.)

The two pattern phases occur together in at least two localities without evidence of intergradation. Intermediates between them are known from San José del Cabo and its vicinity (map 6).

Scutellation

Scale counts in *celaeno* may be summarized as follows: Ventrals in males, 135 to 146, mean 142.1; in females, 134 to 145, mean 141.1. Anal plate divided in all specimens. Subcaudals in males, 74 to 82, mean 78.1; in females, 67 to 75, mean 71.0.

The dorsal scale-row formula is normally 19–17 among males, but there are maxima of 21 rows in 16.7 per cent of the snakes of that sex. In females the maximum number is 21 among 49.3 per cent of the specimens and 19 among 38.8 per cent; three females have maxima of 22 scales, and one has 23 for a short distance. The scale rows are reduced to 17 in all specimens of both sexes, with the exception of one male in which the minimum count is 15.

Dorsal-scale reductions among 10 males are:

19 3+4 (74–83)—*17* (141–144)

Dorsal-scale reductions among four females with maxima of 19 rows are:

19 3+4 (74–92)—*17* (139–143)

Dorsal-scale reductions among three females with decreases from 21 to 17 rows are:

21 4+5 or 3+4 (46–63)—*19* 3+4 (86–104)—*17* (140–141)

Dorsal-scale changes in two females that increase from 19 to 21 and then reduce to 17 are:

19 4+5 (29–42)—*21* 4+5 (45–56)—*19* 3+4 (84–99)—*17* (139–143)

Supralabials usually eight, in some cases seven, rarely nine, and only five in one aberrant specimen. Infralabials usually 10, but nine in 3 per cent of the counts. Normally only a single preocular, but there are two in 5.6 per cent of the counts. Normally three postoculars; two in 21.3 per cent; a count of four in two specimens; and a count of one in three. A single anterior temporal in virtually all cases, but there are two on one side of the head in one specimen. Temporals in second row usually two; three in 7.2 per cent; a count of one in five specimens. Two supralabials, the fourth and the fifth, normally enter the eye, but there are a few variations; only the fourth enters in eight counts, and three scales, the fourth, fifth, and sixth, enter in two counts.

Irregularities: Dorsal scale rows are added irregularly for short distances and then dropped in many specimens of *celaeno*, especially among those from and near Agua Caliente. These make counting difficult, and they are responsible for the increases to 22 and 23 among a few of the females.

The postoculars exhibit numerous abnormalities. The uppermost postocular is fused with the adjacent supraocular on one or both sides of the head in many snakes. This condition occurs 11 times in specimens from or near Boca de la Sierra, twice in snakes from Miraflores, and 24 times in snakes from or near Agua Caliente; in one additional snake from Agua Caliente the fusing is only partial. Other similar abnormalities, occurring one time each and all among snakes from the Agua Caliente area, include (1) fusion of the uppermost postocular with the adjacent parietal, (2) fusion of the two uppermost postoculars with the supraocular to form a single large scale, and (3) fusion of the two lower postoculars to form a single scale. All these involve snakes from interior localities at or in the mountain foothills, but the abnormalities occur among both Dark and Pale snakes. Among the specimens of *celaeno* from the dubious "Cape St. Lucas" locality, fusion of the uppermost postocular with the supraocular occurs five times, thus suggesting that the syntypes may have been collected at an inland locality.

Coloration and Pattern

As pointed out above (pp. 114, 118), members of this complex exhibit two main color patterns: (1) Dark snakes with little or no dorsal pattern except for a pale, irregular, lateral stripe involving the first to third row of scales, and with the belly virtually uniform

black or very dark brown. (2) Snakes with a dorsal coloration of pale gray or brown and marked with four rows of dark spots as in snakes of the subspecies *valida* from mainland Mexico; the belly is whitish or yellowish, either plain or with a light wash or stippling of slightly darker pigment. Members of the first group are designated as the Dark Populations and those of the second as the Pale Populations; they are discussed separately.

Members of the Dark Populations are shown on plates 2 and 10. The left lateral view of the head, a lateral view at midbody, and a ventral view at midbody of an adult female from the Presa El Chorro, 2 miles west of Agua Caliente, are illustrated in color (pl. 2, fig. 4). A dorsal view of the head and neck of the same snake is also illustrated (pl. 10, fig. 3), as well as dorsal and ventral views of another adult female from the same locality (pl. 10, figs. 1, 2). In both of these specimens large, essentially discrete, dark blotches, each involving four or more scales, are apparent, at least on the anterior part of the body. In many younger specimens (pl. 10, fig. 4), and in a large majority of all males (Conant, 1946, p. 267) the dorsum tends to be uniformly black or with only a few and poorly defined indications of markings.

The general coloration of an adult male from the Presa El Chorro near Agua Caliente, Baja California Sur, may be summarized as follows: Dorsal coloration nearly uniform Olivaceous Black (3) but with medium grayish brown (Hair Brown) in the few paler areas where pattern is suggested. Pale lateral stripe olive (slightly paler than Citrine-Drab). Top of head black; spot on sixth supralabial Olive-Buff. Chin and throat almost black (Chaetura Black); venter very slightly paler (Chaetura Drab) and with the posterior and lateral edges of the ventrals somewhat paler. Ventral surface of tail similar but darker. Eye: Pupil black; iris dark brown, nearly black, but exhibiting an orange-brown tinge when viewed in strong light. Tongue: Very dark gray, almost black; tips slightly more gray; base with a faint indication of pink. (The tongue was virtually the same coloration in the female illustrated in color on pl. 2, fig. 4.)

Color notes were also recorded for six small specimens, ranging in total length from 310 mm. to 438 mm., from the Presa El Chorro, and these may be summarized as follows: Dorsums very dark gray, virtually black; Grayish Olive in the few areas where traces of pattern are discernible. Heads black above; a very faint suggestion of a pair of pale spots toward the posterior ends of the parietals in two snakes, but absent from the other four. Spot on sixth supralabial Olive-Buff; small flecks of similar pale pigment on other labials, both upper and lower. Lateral stripe Grayish Olive. Chins and throats virtually plain black, but with small white spots on the throats of five of the six snakes. Venters, including under sides of tails, virtually uniform very dark gray; posterior edges of ventrals somewhat translucent and imparting the effect of slightly paler borders.

The coloration and patterns among the 15 specimens I collected at the Presa El Chorro and Boca de la Sierra exhibit little variation except for the relative degree of conspicuousness of the dark dorsal markings, which are most prominent in large females. Other freshly collected material from localities around the perimeter of the central mountain massif of the Cape Region are similar. The numerous members of the Dark Populations in the large series of specimens that were obtained by Joseph R. Slevin in 1919 and are now in the collection of the California Academy of Sciences are also similar, if proper allowance is made for fading during half a century.

I have seen no live or fresh material of the Pale Populations from Baja California, and comparisons can be made only between preserved specimens from the region and preserved material of the subspecies *valida* from the mainland. The resemblance is striking, and virtually every Pale member of the *valida* complex from the Cape Region can be matched by one or more of the mainland snakes. For example, the most recently collected specimen (N.H.S.S.D. No. 17655, obtained on October 30, 1941, about 1 mile southwest of San José del Cabo) is similar in gross appearance to the specimen of the subspecies *valida* from the Río Mayo in Sonora that is illustrated (pl. 9, fig. 1).

Among the Pale Populations, the number

of dark spots in one of the lower rows varies among seven males from 80 to 97, mean 87.3, and among 12 females from 75 to 92, mean 86.3. The spots are thus considerably more numerous than they are in any of the three mainland races of *valida* (table 14). In addition there is a tendency, at least among the smallest specimens, for dark pigmentation to appear on the edges of an exceptionally large number of scales and thus to produce the effect of strongly spotted snakes. The extra markings disappear or are only vaguely indicated in the larger Baja specimens, in which the dark spots are normally arranged in four rows as they are among most snakes of the subspecies *valida*.

Size and Sex

The 10 largest females have measurements as follows: Head-body length, 730 mm. (total length 958+ mm.); 709 mm. (945 mm.); 692 mm. (917 mm.); 676 mm. (886 mm.); 667 mm. (871 mm.); 667 mm. (790+ mm.); 663 mm. (881 mm.); 658 mm. (799+ mm.); 641 mm. (837 mm.); and 608 mm. (796 mm.). Comparable measurements for the 10 largest males are: 712 mm. (955 mm.); 651 mm. (832+ mm.); 646 mm. (874 mm.); 643 mm. (853 mm.); 606 mm. (842 mm.); 603 mm. (787+ mm.); 575 mm. (755+ mm.); 574 mm. (689+ mm.); 568 mm. (760 mm.); and 556 mm. (615+ mm.). Among these the largest female and three other females are members of the Pale Populations, and the two largest males and one other male are also members of the Pale Populations. The fact that the largest snakes of each sex have *valida*-like patterns is probably an accident of sampling. Comparison with measurements of snakes of the other races of *valida* indicates that males of *celaeno* attain a greater size than males of any other subspecies.

No young of *celaeno* were born in captivity, but two apparently full-term embryos, measuring 195 mm. and 199 mm., respectively, were removed from a female measuring 917 mm. in total length that was caught at Miraflores and preserved on July 28, 1919. Because there were only two young and most *Natrix* litters include considerably greater numbers, it is presumed the mother was collected after giving birth to other offspring. Newborn juveniles of the subspecies *valida* and *thamnophisoides* are of comparable size (table 21). The seven smallest wild-caught juveniles of *celaeno* measured from 230 mm. to 240 mm. in total length.

Tail length/total length ratios for males of all sizes are 0.24–0.28 (0.261); for females, 0.23–0.26 (0.247).

Ecology and Natural History

The Cape Region of Baja California differs in many respects from the more northern and especially the central parts of the long, narrow, desiccated peninsula of which it forms the distal tip. There is considerably more precipitation in the uplands, variations in daily temperatures are not so pronounced as in the desert farther north, tropical deciduous forest (the thorn scrub of some authors) clothes much of the area, and pine-oak forest occurs at high elevations (Leopold, MS).

The Cape Region is dominated by a series of mountain ridges, largely trending west to east, which collectively form an elongated central massif extending from a short distance north of the Tropic of Cancer southward for approximately 40 miles toward Cabo San Lucas. These granitic mountains, some of which are known as the Serranía del Cabo, Sierra de La Laguna, Sierra Victoria, Pico San Antonio, rise to elevations above 6000 feet. Rainfall is most abundant at the higher levels and supports several small streams as well as the forests of oak and pine.

Leviton and Banta (1964, pp. 129, 132–133) included a brief general description of the region. Information on numerous surface features is available in a guide book to Baja California (Gerhard and Gulick, 1958, pp. 149–165). The geological history of the Baja California peninsula as a whole was recently reviewed by Durham and Allison (1960).

Water descending from the mountains through rocky arroyos provides habitats for *Natrix* in the form of pools and small streams, and, when the flow is sufficient, the streams continue onward to follow normally dry channels into or across the surrounding dissected arid plains that are broadest on the eastern side of the central range. Occasionally, after violent autumn storms called *chubascos*, there are destructive floods that

have washed out villages (Meigs, 1966, p. 105). Many springs, most numerous near the foot of the mountains, provide oases where villages are established and limited agriculture is practiced. Presumably *celaeno* formerly occurred in many of these areas, and it may still be present in a number of them, but confirmation is lacking.

The semitropical climate of the Cape Region, correlated with a scrutiny of the dates of collection of specimens of *celaeno*, suggests that water snakes of this complex probably are active throughout the year. Many more have been taken in summer than in winter, however, which may reflect the activities of the collectors rather than those of the snakes.

Our limited experience with water snakes of this taxon indicates that they are diurnal. We caught 15 on September 14 and 15, 1961, seven during the morning hours and eight during the afternoon; none was encountered at night. Most were taken at the Presa El Chorro, about 2 miles west of Agua Caliente. The dam forms a small impoundment near the end of an arroyo that incises the base of a mountain designated as "Mount San Rafael," according to Van Denburgh and Slevin (1921, p. 68). The name "El Chorro" is derived from small jets of water issuing from rocks at one side of the pond which Gerhard and Gulick (1958, p. 155) described as "hot springs" but which were inactive during our visit. Much of the perimeter was bordered by large, barren boulders (pl. 22, fig. 2), but there was a small patch of tules in one area, and part of one shore was marshy and overgrown with weeds and thorny trees. A relatively new concrete canal about a meter in width (pl. 22, fig. 1) carried water toward the village, and 12 specimens of *celaeno* were collected along a portion of it measuring about 300 yards in length. In cross section the canal was roughly U-shaped, the sides were smooth and rather steeply sloping, and the concrete bottom was covered in most places by a thin layer of sand above which clear water was flowing. Several patches of algae were present, but, in general, the canal was otherwise bare of hiding places. Probably because of its newness, only a few scattered plants had grown sufficiently to overhang the water (pl. 22, fig. 1). A large adult of *celaeno* was collected in the vegetation illustrated, and two small individuals were also found stretched out in clumps of plants above the water. The other nine specimens were in the canal or adjacent to it in areas that were muddy as a result of leakage. Some of the snakes sought shelter in the algae, but most simply swam along the canal, either with or against the current, in their efforts to escape.

Air, water, and cloacal temperatures were recorded immediately after the capture of six specimens that were taken in the water in the canal at irregular intervals between 8:00 A.M. and 9:10 A.M. during the sunny morning of September 15, 1961. Air and water temperatures showed a steady and gradual increase, but those of the snakes did not (table 18). A cloacal temperature did not

TABLE 18

CLOACAL AND ENVIRONMENTAL TEMPERATURES FOR A SERIES OF *Natrix valida celaeno* FROM NEAR AGUA CALIENTE, BAJA CALIFORNIA

Date, in 1961	Time	Temperature in Degrees Centigrade			Approximate Total Length of Snake in Mm.
		Air	Water	Cloaca	
Sept. 14	8:00 P.M.	26.4°	30.8°	[a]	[a]
Sept. 15	8:00–9:10 A.M.	26.4°	30.0°	30.0°	750
		26.4°	30.0°	29.8°	450
		27.2°	30.2°	30.2°	600
		27.6°	30.2°	28.6°	750
		27.8°	30.4°	30.0°	750
		27.9°	30.4°	28.6°	400

[a] None collected at night.

exceed that of the water in any case. In four instances the snakes were cooler than the water, suggesting that they had either been resting in the shade or, what is more likely, had just emerged from underground retreats. Inasmuch as a repeated search for several hours along the canal, the vicinity of the dam breast, and the accessible portions of the perimeter of the impoundment had been fruitless during the previous evening, it was assumed the snakes had remained in hiding during the hours of darkness, although comparable air and water temperatures had been prevalent at 8:00 P.M.

The diurnal activity may have been associated with feeding habits. Residents of a few small houses situated near the canal stated that fishes were absent from the arroyo and impoundment. The only food animal we found, and it was much in evidence, was *Bufo punctatus*. Many toads of various sizes appeared during the evening near the lantern at our campsite, but, during the fruitless nocturnal search for snakes, only two toads were seen, and both were large and in the canal.

During the morning period when the six specimens of *Natrix* were collected, however, approximately 24 small individuals of *Bufo punctatus* were seen in the water, all at the bottom edge of the slanting concrete aprons forming the sides of the canal. Their behavior, when approached, was, without exception, to hop rapidly up the slope and then into the gravelly terrain adjacent to the canal. There they stopped immediately and became virtually invisible against the dark stony background. Many toads probably fall or wander into the canal at night, and the small ones are suitable as food for even the smallest specimens of *celaeno*. The presence of the snakes in the canal at the same time suggests that they may have been patrolling in search of toads. A young specimen of *celaeno*, found in brush over the canal during the late morning, disgorged a small *Bufo punctatus* that was partially digested.

We collected three other water snakes at Boca de La Sierra, during the afternoon of September 15, where the environmental conditions were similar. Several young ones, conspicuous because of their black coloration against the gray of the granite rocks, were seen swimming in an impoundment formed by a dam across the Arroyo San Bernardo, a half mile or more above the small settlement. A narrow canal, measuring approximately 1 meter deep and 1 meter wide and with a concrete base and vertical sides formed of masonry, carried water to the nearby village and fields. The gradient, in part, was steep, and water was rushing down the canal at great speed when we arrived in early afternoon. By the time we climbed upward along the arroyo to the dam, a gate had been closed, only a trickle of water was flowing, and the canal was virtually dry. A medium-sized individual of *celaeno* was found under a mass of algae in a portion of the canal that was essentially level and where the flow must have been moderate. Whether the snake had been in the canal when it contained water or entered after the gate was closed was not determined. The masonry provided numerous chinks and crevices in which snakes and other small animals could hide.

Alan E. Leviton and Neil D. Richmond also collected specimens in the same canal, and Richmond obtained several additional ones in long, deep pools above the dam and at higher elevations along the Arroyo San Bernardo. All their snakes were caught during daylight hours, as were mine.

Bufo punctatus is almost without doubt the most important food item utilized by the *celaeno* population at Agua Caliente and probably at several other localities as well. The following notes, based in large part on the series of 49 specimens collected at that locality by Joseph R. Slevin from July 23 to July 25, 1919, inclusive, are from my earlier paper on the subspecies of *Natrix valida* (1946, p. 269): "The stomachs of the great majority of the snakes of the Agua Caliente series contain toadlets or nearly transformed tadpoles of *Bufo punctatus*. A few also have toads in their throats. The toadlets have head-body lengths of 9 or 10 mm.; the head-body lengths of the tadpoles are the same and many have tails 6 mm. long. Sixteen toadlets were removed from the throat and stomach of a snake 520 mm. long—also a nymphal roach 6½ mm. long. One of the snakes in the collection of the Chicago Natural History Museum has a medium-sized *Bufo punctatus* in its mouth."

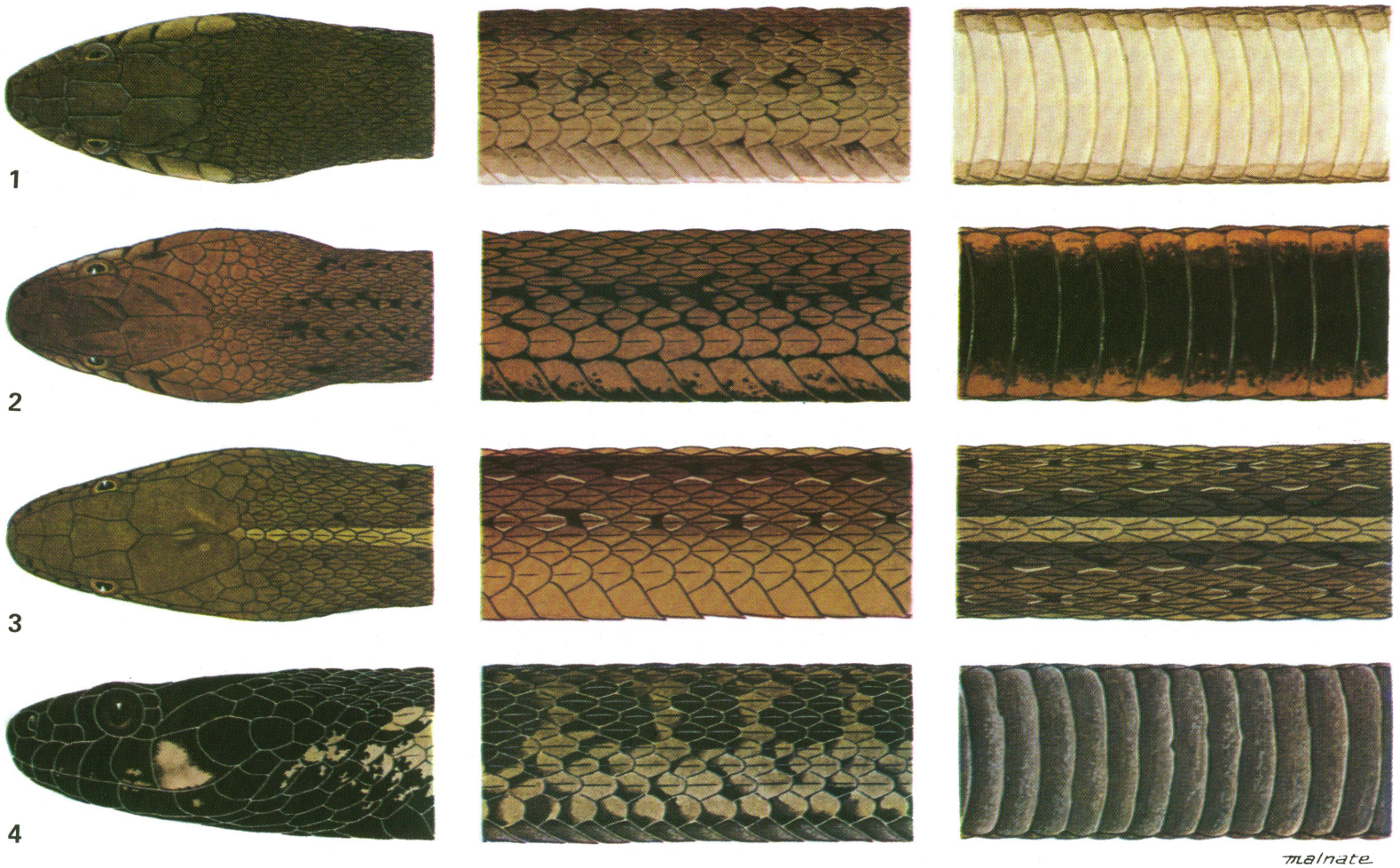
We collected a small series of *Hyla regilla* in a marshy area at one side of the dam breast at Boca de La Sierra, and Richmond found that species breeding there. This frog probably also serves as food, but there is no evidence to indicate whether *Scaphiopus couchi* is eaten. Aside from *Bufo punctatus* and *Hyla regilla*, *Scaphiopus* is the only amphibian indigenous to the Cape Region (Leviton and Banta, 1964, p. 152).

Van Denburgh (1896, p. 154), in reporting on a collection of *celaeno* from near the coast, noted that "Some of the specimens contained small fish, *Mugil brasilensis*." (These specimens were lost when the California Academy of Sciences was destroyed by earthquake and fire in 1906.) In view of the rarity of fishes in bodies of fresh water in Baja California (Follett, 1960), it is probable that any mullets and other fishes entering streams of the Cape Region from the sea constitute a relatively small part of the diet of the populations of *celaeno* as a whole. Whether insects, such as the roach mentioned above, are deliberately eaten or are ingested accidentally with other food is not known.

Although they may not encounter fishes in nature, captive specimens of *celaeno* from near Agua Caliente readily recognized small fishes as food, and they greedily consumed leopard frogs. *Rana pipiens* not only is absent from the Cape Region but from virtually all of Baja California (Stebbins, 1966, map 51).

The whipsnake, *Masticophis flagellum piceus*, may be an important predator on *Natrix valida celaeno*. On three occasions we noted large ones, 5 feet or more in length, patrolling the canals or their immediate environs. During the inspection of the aqueduct leading to Boca de La Sierra we saw a whipsnake with the posterior part of its body resting on the bank but with the remainder of its length hanging down into the canal. Its head was probing first in one direction and then another. The water had just been turned off, and the snake had approached the aqueduct immediately after our passage; probably it had waited concealed as the seven members of our party, including native boys, passed it. Not more than a minute later I picked up a water snake in the canal in a situation virtually identical with that in which the whipsnake was searching.

Nothing has been reported on the breeding habits of this race of *Natrix valida*.



Coloration in Mexican water snakes. *Left to right:* Dorsal views of heads, lateral views at midbody, and ventral views at midbody (except as noted). 1. *Natrix valida isabelleae,* type, female, A.M.N.H. No. 73171, 814 mm.; Pie de la Cuesta, 8 miles northwest of Acapulco, Guerrero. 2. *Natrix valida,* a partially melanistic member of an intergrading population, male, A.M.N.H. No. 84090, 648+ mm.; Rosamorada, Nayarit. 3. *Natrix valida thamnophisoides,* type, female, A.M.N.H. No. 84091, 605 mm.; Río San Cayetano at Puente San Cayetano, 3.5 miles southeast of Tepic, Nayarit. The right figure is a dorsal view at midbody. 4. *Natrix valida celaeno,* female, A.M.N.H. No. 94601, 799+ mm.; near Presa El Chorro, Agua Caliente, Territorio Sur de Baja California. The left figure is a lateral view of the head

MISCELLANEOUS NOTES

ASSOCIATION WITH SEMIAQUATIC FORMS OF *THAMNOPHIS*

AN INSPECTION OF THE three general distribution maps (maps 1, 2, and 4) clearly shows that snakes of the genus *Natrix* are absent from most of the Mexican plateau. In that part of Mexico the "water snake niche" is occupied by members of the genus *Thamnophis*, notably of the species *eques*, *melanogaster*, and *rufipunctatus*. All three occur with *Natrix erythrogaster bogerti* in the Río Nazas system in Durango (Conant, 1963c, p. 476); *eques* and *melanogaster* occur with *Natrix erythrogaster alta* in the Río Aguanaval in Zacatecas (*loc. cit.*) and with *Natrix valida thamnophisoides* at the Puente de San Cayetano, near Tepic, Nayarit (Conant, 1961, pp. 1, 12, and unpublished data). On the southern part of the plateau snakes of the species *eques* are stout and rather heavy-bodied and attain a very large size (at least 4 feet in length). Especially in the larger lakes, such as the Lagos or Lagunas de Atotonilco, Cajititlán, Chapala, Cuitzéo, Pátzcuaro, and Yuriria, *eques* is "the" water snake and is frequently seen swimming even at long distances from shore. On the other hand, *melanogaster* is comparatively small, secretive, and inconspicuous throughout its range. It is almost invariably found with *eques* from the headwaters of the Río Florido (Rio Grande drainage) southeastward at least to the Valley of Mexico. To the north, the relatively small *Thamnophis rufipunctatus* occurs with *eques* from Durango through Chihuahua to central Arizona. The approximate ranges of these three semiaquatic species of *Thamnophis* were delineated in Conant (1963c, pp. 495–97). Only in the few areas mentioned above are they known to be sympatric with water snakes of the genus *Natrix*.

EFFECT OF DAMS AND CANALS ON THE DISTRIBUTION OF *NATRIX* AND THE SEMIAQUATIC FORMS OF *THAMNOPHIS* IN MEXICO

The practice of diverting water from streams into irrigation ditches, which is widespread in arid portions of Mexico, is probably almost as ancient as the history of agriculture. Primitive methods, such as partially damming a small stream to direct water into a sluiceway or hand-dug canal for use of a village or hacienda, have little effect on the aquatic and semiaquatic fauna, but the great dams, with their attendant hydroelectric and irrigation projects, that have been developed during recent decades are another matter. Some are adversely affecting habitats, resulting in the drastic reduction or extermination of whole populations. Conversely, some have served to broaden the range of certain species, creating new habitats and permitting migration from one drainage system to another.

Unfavorable alterations of *Natrix* habitats by human activities were noted in many localities, and brief comments on some of these follow.

Impoundment of the water of the Río Nazas in extreme eastern Durango in the Laguna District, centering around the cities of Torreón, Gómez Palacio, and Ciudad Lerdo, has probably resulted in the extirpation of *Natrix erythrogaster bogerti* in Coahuila, a state into which the river once flowed. Certainly *bogerti* has disappeared from the lowermost part of the former course of the river, which is now normally dry even during the rainy season (Conant, 1963c, p. 475).

The large spring (Ojo de Agua) 4 miles west of Sabinas Hidalgo, Nuevo León, with its associated run, was still a good habitat for *Natrix rhombifera rhombifera* and *Natrix erythrogaster transversa* during the several times we did field work there (in 1949, 1954, and 1960). Previously, according to residents of the region, some miles of the Río Sabinas were available to these snakes except during the driest seasons, but the stream is now diverted into a conduit for the use of the

city, and the run is reduced to the length of a few hundred yards.

Water that formerly flowed in a natural stream through the Cañon de la Huasteca near Santa Catarina, Nuevo León, has been diverted into three separate small canals (Kallman, 1964, p. 516), with consequent reduction of habitat. No water snake has been reported from this locality since 1954, although it is possible that *transversa* still survives there. The Cañon de la Huasteca is probably the type locality for *Nerodia couchii* Kennicott (=*transversa*). (See p. 27.)

Numerous other examples could be listed or cited. Conversely, however, the works of man may inadvertently result in the preservation of various organisms, as Minckley and Koehn (1965, p. 314), reported in the case of a fish. According to them the Río Sauz, a small intermittent stream flowing eastward across the desert about 30 miles north of Ciudad Chihuahua, Chihuahua, had been dry for many years, and Miller (1961, p. 393), in commenting on *Cyprinodon eximius*, had indicated that the population of that species isolated in the Río Sauz was probably extirpated. A field party, however, found three species of fishes, including *C. eximius*, on June 1, 1964, living in a small impoundment formed behind a crescent-shaped dike that trapped outwash water from an arroyo descending from the mountains to the west.

The practice of permitting some water to flow continually downstream from the big dams for the use of Indian villages occupying riparian sites has tended, however, to preserve populations of *Natrix*, *Thamnophis*, and many other species of animals, although their numbers may be fewer as a result of decreased water volume. Many of the big dams have also served to reduce the frequency of destructive floods, thus decreasing the attrition upon those species less well able to withstand rushing water and the scouring effect of the sand, gravel, and other materials transported by it. Such vagile animals as water snakes may be less affected by most floods than are the truly aquatic species, because they can take refuge out of the water in trees, rock piles, or on the banks of swollen streams.

The construction of some dams has destroyed habitats by inundating them. Other impoundments have created new ones, but it may be some time before *Natrix* and other semiaquatic animals take advantage of the new sites, because the raw edges of the newly originated lakes, with their lack of vegetative cover, do not provide the hiding places they need. Conversely, dams and associated sluiceways built of loose stones often harbor large *Natrix* and *Thamnophis* populations.

Whatever the effects of the dams themselves may be, at least some of the irrigation canals fed by their waters have created excellent habitats and migration routes for water snakes. Canals with earthen banks soon are bordered by vegetation, and frogs and fishes are usually available as food. Small canals constructed by hand labor have proved to be excellent places in which to hunt for water snakes as we discovered, for example, near Rancho Grande, Zacatecas (*alta*), near Llera, Tamaulipas (*blanchardi*), and near Cihuatlán, Colima (*isabelleae*). Concrete canals of large size do not provide suitable habitats, but smaller ones may, as in the concrete sluiceway (pl. 22, fig. 1) conveying water away from the Presa del Chorro near Agua Caliente, Baja California Sur, and along which I collected a dozen specimens of *celaeno*. Some were in vegetation overhanging the water, but others were swimming in the canal itself.

Two areas may be mentioned as examples of how the activities of man have created migration routes for water snakes. One is in the great irrigation districts involving the Ríos Yaqui, Mayo, Fuerte, and Sinaloa, of southern Sonora and northern Sinaloa. An inspection of the map in Dozier (1963, p. 549) and sheet number 14 (12R-VI) of "La carta geográfica de la República Mexicana" (Ex-Comisión Intersecretarial, 1958) shows that water-dependent organisms now have a network of channels for moving from one locality to another. Theoretically *Natrix valida* could migrate from the Río Mayo to the Río Yaqui, or vice versa, or from the Río Fuerte to the Río Sinaloa. Formerly all four river systems were isolated from one another, and the aquatic and semiaquatic components of the fauna and flora were confronted by formidable if not impassable barriers of arid desert.

The other area is in the Cuatro Ciénegas *bolsón* of central Coahuila where endemism is pronounced among the fishes (Minckley, 1962; Miller and Minckley, 1963; and Hubbs and Miller, 1965), turtles (Legler, 1960; Webb and Legler, 1960; and Webb, Minckley, and Craddock, 1963), and snails (Dwight W. Taylor, 1966, p. 152). Cole and Minckley (1966) also recently described a new isopod from one of the *pozos* of the *bolsón*. Formerly each of many large springs of the basin and their associated *ciénegas* (marshes) had their own more or less isolated demes of organisms, and gene imports probably occurred only occasionally through underground channels or, in the case of the water snakes, also by overland wandering during rare periods of wet weather. To supply water for irrigation and more recently for the use of steel mills in Monclova, however, ditches have been dug (the earliest about 1898), channeling the runoff into master waterways so that the more vagile organisms can now readily pass, at least theoretically, from one formerly isolated area to another. Hybridization has apparently resulted among some of the fishes (Minckley, in press). There is some evidence that the plastic *Natrix erythrogaster* varied in minor details of coloration and pattern from one *pozo* and its environs to another, but movements of the snakes along the canals probably have now mixed the gene pools to at least some, and possibly to a considerable, degree.

FIELD NOTES

Data on the environment were recorded at 31 of the localities where specimens of *Natrix* were collected in Mexico. In general, these included: (1) an approximation of the relative acidity or alkalinity of the water in which the snakes were found; and (2) temperature readings of both the water and the adjacent (shaded) air. Cloacal temperatures were also recorded for some of the animals; these appear at numerous places in the text and in table 18.

Power of hydrogen readings were obtained through the use of a pHydrion paper dispenser (AB pH 1-11) manufactured by the Micro Essential Laboratory, Inc., Brooklyn, New York. By far the most common reading was pH 6, but values ranging from pH 5 to pH 7 also were obtained. Although the data are admittedly few, there is a suggestion that snakes of the *valida* complex may tolerate slightly more acid water than snakes of the other two species. The only pH 5 reading obtained in any *Natrix* habitat in Mexico was near San Blas, Nayarit, where the water was slightly brackish. A pH of 5.5 was noted at the Hacienda de García, southeast of Tepic, Nayarit. All other readings within the range of *Natrix valida* were pH 6 except in a small, rapidly drying pool northeast of La Huerta, Jalisco, where it was pH 7. The low reading at San Blas was obtained in the area where melanism is pronounced among the snakes (see p. 94), but in the foothills of the *sierra* in Baja California, where all specimens collected were strongly melanistic, the pH was 6. In contrast, all readings for the habitats of *N. erythrogaster* and *N. rhombifera* were pH 6, with two exceptions, one each of pH 6.5 and pH 7. Most specimens of *Natrix* from Mexico were taken in flowing streams or other bodies of water closely associated with them.

No specimens of *Natrix* were found in the alkaline waters of landlocked lakes such as those that are inhabited by *Thamnophis eques* and *T. melanogaster* on various parts of the Mexican plateau. Both species of garter snakes are abundant in the Lago de Cuitzéo, Guanajuato and Michoacán (pH 8), and the Lago de Atotonilco, Jalisco (pH 9). A single individual of *T. eques* was taken in a puddle (pH 10) near the eastern edge of the marshes east of El Carmen, Tlaxcala.

Temperatures were obtained through the use of quick-recording thermometers distributed by the Schultheis Corporation of Brooklyn, New York. Water temperatures were usually noted at a depth of 1 or 2 inches beneath the surface. Air temperatures were taken within 1 foot of the surface and shaded, if necessary, by my own shadow. Most were recorded at night, and care was taken to make sure the instrument was perfectly dry so the reading would not be affected by

evaporation. Temperatures on the snakes were made by inserting the bulb in the cloaca and keeping the fingers as far removed as possible in order to negate heat transfer from them to the body wall of the live snake and secondarily to the thermometer.

Water temperatures recorded for the members of the three species complexes may be summarized as follows: *erythrogaster*, 18.7° C. to 29.7° C., mean 24.3° C.; *rhombifera*, 24.5° C. to 30.0° C., mean 27.7° C.; and *valida*, 22.6° C. to 33.0° C., mean 29.1° C. In general, these measurements reflect the altitudes at which the animals are distributed. The lowest measurement for *erythrogaster* was recorded in the high plain of Zacatecas at an elevation of 6500 feet (1981 meters), and other temperatures taken on the *altiplano* influenced the low value of the mean. Most records for both *rhombifera* and *valida* are from the Gulf and Pacific coastal plains, respectively, where temperatures would be expected to be higher than those in the uplands.

Snakes occasionally were taken near water that was at even higher temperatures. One such (a specimen of *transversa*) was found in the outflow ditch from the Pozo de Escobedo in the Cuatro Ciénegas *bolsón* in Coahuila. It was crawling along a ledge under an overhang on the bank a few inches above the water surface, and, as it was wet, it probably had been swimming. Unfortunately a cloacal temperature could not be recorded, because I had just broken my thermometer. The temperature of the water, taken a short time later, was 33.4° C.

Air temperatures, as would be expected, were almost invariably lower than water temperatures at night or during the early morning. From late morning onward the air temperatures were higher.

CAPTIVE SPECIMENS

It was our practice, while collecting in Mexico, to keep gravid females of all natricine snakes alive until after the birth of their young. Each was caged separately, inspected daily, given water at least every other day, and offered food, usually *Rana pipiens* or small frogs or fishes, whenever possible. Some young were born en route, but parturition in other females did not occur until after our arrival at our home base.

As we made no attempt to transport a delicate balance in the field, measurements of weights are not available in many instances for either the females or their litters, but such data were recorded when births occurred at our home laboratory or at the Philadelphia Zoological Garden. In most cases the young appeared to be normal and well within the range of variation of their respective forms both in scutellation and color pattern. Runts, deformed specimens, and partially developed (in some cases nearly full-term but usually dead) embryos occasionally accompanied the litters of apparently normal young. Such abnormal individuals are not included in the summaries of scutellation, and they are also omitted from the tables, except where mentioned in footnotes. Weights and measurements were recorded within two or three days after birth. Pertinent data on the litters and their female parents are given in tables 19–21.

In addition to maintaining gravid females, we kept numerous other water and garter snakes alive for various periods of time and for various purposes: to serve as models for the photographer and artist, to provide information on behavior and feeding habits, and to obtain shed skins on which to check for the presence or absence of apical pits on the dorsal scales (Conant, 1961, p. 18). Some snakes were maintained in my office at the Philadelphia Zoological Garden, where the vagaries of steam heat resulted in their being exposed, during the winter months, to temperatures that varied from 10° C. (at night) to 30° C., sometimes within a single 24-hour period. Summertime temperatures fluctuated from 20° C. to 30° C. daily, with the normal rhythm reversed because of the use of air-conditioning equipment during daytime working hours. Conditions at our home, where many of the snakes were kept, were

TABLE 19

LITTERS OF YOUNG IN *Natrix erythrogaster* FROM MEXICO

Subspecies	Locality and Date of Collection of Female Parent	Date of Birth	No. of Young	Measurements[a] in Mm.	Weights[a] in Grams	Length of Female in Mm.		Weight of Female in Grams
						Total	Head-Body	
transversa	Ojo de Agua, W. of Sabinas Hidalgo, Nuevo León, May 16, 1954	July 9, 1954	32	191–279 (249.9)	3.5–9.4 (7.6)	1277	966	590
transversa	El Cariño, 8 miles W. of Nadadores, Coahuila, Aug. 3, 1960	Aug. 5, 1960	11	252–267 (260.2)	—	898	681	—
transversa	El Cariño, 8 miles W. of Nadadores, Coahuila, Aug. 3, 1960	Oct. 4, 1960	12	207–242 (227.8)	3.8–6.2 (5.4)	883	660	201
transversa	El Cariño, 8 miles W. of Nadadores, Coahuila, Aug. 3, 1960	Nov. 29, 1960	7	222–247 (238.1)	4.3–7.6 (5.8)	793	600	193
transversa	El Cariño, 8 miles W. of Nadadores, Coahuila, July 4, 1962	Aug. 4, 1962	9	232–283[b] (263.3)	6.0–10.9[b] (8.5)	854	652	—
transversa	El Cariño, 8 miles W. of Nadadores, Coahuila, July 4, 1962	Sept. 8, 1962	13	225–260 (244.3)	6.5–7.7 (7.1)	880	675	233
transversa	Near Pozo de Escobedo, 9 miles S. of Cuatro Ciénegas, Coahuila, July 7, 1962	Oct. 9, 1962	2	203, 230	3.5, 5.3	872	662	230
bogerti	Nazas, Durango, July 12, 1962	Oct. 8, 1962	9	230–246 (235.9)	4.9–6.2 (5.4)	769	587	161
alta	Río Medina, near Rancho Grande, Zacatecas, Aug. 21, 1960	Sept. 1, 1960	23	243–274 (261.8)	5.2–7.8 (6.6)	1130+	875	518
alta	Río Medina, near Rancho Grande, Zacatecas, Aug. 21, 1960	Sept. 13, 1960	14	253–272 (265.7)	5.4–7.6 (6.7)	1105	848	417
alta	Río Medina, near Rancho Grande, Zacatecas, Aug. 21, 1960	Sept. 19, 1960	9	267–280 (274.1)	7.7–9.1 (8.5)	1105+	840	449
alta	Río Medina, near Rancho Grande, Zacatecas, Aug. 21, 1960	Sept. 23, 1960	16	244–279 (268.4)	6.4–8.5 (7.6)	1000+	855	436
alta	Río Medina, near Rancho Grande, Zacatecas, Aug. 21, 1960	Sept. 30, 1960	14	242–263[c] (255.9)	6.6–8.9[c] (8.0)	1070	825	352
alta	Río Medina, near Rancho Grande, Zacatecas, Aug. 21, 1960	Sept. 30, 1960	17	223–270 (261.3)	6.8–8.3 (7.8)	1105+	920	492
alta	Río Medina, near Rancho Grande, Zacatecas, Aug. 21, 1960	Sept. 13, 1962	1[d]	233	6.5	1110	860	575

[a] Extremes are indicated; means in parentheses.
[b] Measurements on seven specimens only.
[c] Measurements on 13 specimens only.
[d] A case of amphigonia retardata (see Conant, 1965b, p. 142); born to same female that gave birth to 14 young on September 30, 1960.

less variable: (1) during the winter they were seldom below 20° C. at night and remained close to 22° C. by day, except when there was bright sunlight which was permitted to shine into a portion of each cage for an hour or more each day; and (2) during the summer months all specimens remained at ambient temperatures that approximated those of shaded situations out of doors.

All snakes were kept in dry aquariums floored with folded newspapers and equipped with shallow water dishes, pieces of cork bark for hiding places, and screened wire tops.

TABLE 20

LITTERS OF YOUNG IN *Natrix rhombifera* FROM MEXICO

Subspecies	Locality and Date of Collection of Female Parent	Date of Birth	No. of Young	Measurements[a] in Mm.	Weights[a] in Grams	Length of Female in Mm.		Weight of Female in Grams
						Total	Head-Body	
rhombifera	Río Sabinas at San Juan de Sabinas, Coahuila, Aug. 2, 1960	Oct. 8, 1960	12	245–269 (258.1)	7.1–10.0 (8.9)	880+	745	363
rhombifera × *blanchardi*	Salinas Victoria, Nuevo León, May 10, 1954	Sept. 10, 1954	15[b]	—	—	944	732	319
rhombifera × *blanchardi*	Ciénega de Flores, Nuevo León, May 14, 1954	Sept. 11, 1954	31	269–290[c] (279.5)	9.1–12.0[c] (10.4)	1190+	982	768
werleri	11 miles SE. of Alvarado, Veracruz, July 18, 1962	July 20, 1962	14	273–295[d] (284.4)	—	1128	—	—

[a] Extremes are indicated; means in parentheses.
[b] All young deformed.
[c] Measurements on 12 only; remainder of litter deformed.
[d] Data recorded in the field by John R. Meyer; living young removed from the mother (see p. 76).

Because the snakes often were observed several times daily, many notes on feeding and other activities were assembled. Those for members of the *valida* complex are summarized below. Notes on members of the *N. erythrogaster* and *N. rhombifera* groups were basically similar, and many are recorded elsewhere in this paper. Many of the data accumulated on the two latter species, however, as well as the voluminous notes on garter snakes, especially *Thamnophis eques*, are reserved for future publication.

Most specimens adjusted quickly to captivity, which facilitated moving them by hand when their quarters were cleaned. Although a large number bit us when they were collected, most became tame within a few days. Two or three large ones, however, re-

TABLE 21

LITTERS OF YOUNG IN *Natrix valida* FROM MEXICO

Subspecies	Locality and Date of Collection of Female Parent	Date of Birth	No. of Young	Measurements[a] in Mm.	Weights[a] in Grams	Length of Female in Mm.		Weight of Female in Grams
						Total	Head-Body	
valida	1 mile E. of Teacapán, Sinaloa, April 15, 1960	July 13, 1960	20	205–223[b] (214.0)	—	788	601	—
valida	Near the Río Presidio, ½ mile N. of Villa Unión, Sinaloa, June 6, 1963	June 6, 1963	34	198–219 (208.8)	—	924+	704	—
valida	Locality unknown	Aug. 1, 1967	22	197–213 (203.9)	3.2–4.1 (3.5)	703+	628	163
thamnophisoides	Río San Cayetano, 3.5 miles SE. of Tepic, Nayarit, July 4, 1959	July 8, 1959	22	170–189[c] (178.8)	—	690	521	—
thamnophisoides	Río San Cayetano, 14 miles SE. of Tepic, Nayarit, July 7, 1959	July 11, 1959	12	168–177 (173.0)	—	639	474	—
thamnophisoides	Río San Cayetano, 14 miles SE. of Tepic, Nayarit, July 7, 1959	Aug. 4, 1959	4	165–169[d] (167.0)	1.4–1.8[d] (1.6)	516+	467	—
thamnophisoides	Río San Cayetano, 3.5 miles SE. of Tepic, Nayarit, Sept. 2, 1961	Sept. 22, 1961	8	173–190 (182.4)	—	551+	444	—

[a] Extremes are indicated; means in parentheses.
[b] Measurements on 13 specimens only.
[c] Measurements on 21 specimens only.
[d] Measurements on three specimens only.

mained aggressive and struck at every opportunity as long as they were kept alive, almost two years in one case.

Food was offered at least once a week, but at more frequent intervals during hot weather. It was our practice to seine for small fishes from or near our dock on the shore of Taunton Lake, Burlington County, New Jersey, and to feed the catch to the captives immediately. Three species of fishes were commonly caught: (1) eastern creek chubsuckers, *Erimyzon oblongus*, ranging from 30 mm. to 80 mm. in standard length; (2) pumpkinseeds, *Lepomis gibbosus*, none used with a standard length exceeding 40 mm.; and swamp darters, *Etheostoma fusiforme*, averaging 25 mm. *Rana pipiens* was the staple food during the winter months, and frogs were also used at intervals during other seasons.

Darters and chubsuckers were swallowed head or tail first, but, in the case of the pumpkinseeds that were capable of erecting the spines of their dorsal fins, the snakes soon learned to maneuver them into position to swallow them head first. After a few weeks of feeding, many of the captives looked upward as soon as the cage lids were touched, and several crawled over the top of the cages toward my hands, stimulated, no doubt, by my movements and the smell of the fishes. They persisted in this behavior even when they were put back into their cages and live fishes were dropped into their water dishes. Some of the larger ones seized my fingers and attempted to swallow them.

Although most of the snakes fed most voraciously during hot weather, they continued to accept food through the cooler months. Cloacal temperatures were recorded for a number of snakes immediately after they had swallowed specimens of *Rana pipiens*, and the following items, culled from my notes for the period from October 22, 1961, to May 23, 1962, are based on the subspecies *celaeno* except as noted:

20.6° C., 7:40 A.M., October 22; large adult female ate frog that had been in cage several days.

21.7° C., 6:15 A.M., November 4; another large adult ate frog that was in cage two days; just beginning to get light out of doors.

21.6° C., 10:00 P.M., November 13; adult male (subspecies *valida*).

22.2° C., 8:30 P.M., December 18; adult female.

25.2° C., 9:45 P.M., March 30; large female being used as model for artist.

24.6° C., 8:45 P.M., April 22; large, very fat female ate frog of medium size.

25.8° C., 10:15 P.M., May 23; model ate two frogs of medium size.

These temperatures, which include the extremes recorded for captive *valida*, may be compared with those noted in the field among specimens of *celaeno* that presumably were actively foraging (table 18) and specimens of *thamnophisoides* that were emerging into the open during mid-morning (p. 109).

One unusual skin shedding was noted. A large female of *thamnophisoides* that subsequently gave birth to a litter of young was in poor condition when collected. There were several necrotic areas on the skin that rapidly disappeared under a daily program of cleansing and drying, but the left eye was so badly infected that the sight had been destroyed. This snake did not shed until almost six months after capture. At that time two readily separable layers of skin were sloughed as a unit, except from the the area adjacent to the left eye.

SUMMARY

THIS STUDY IS CONCERNED primarily with geographical distribution and variation among the three species of water snakes of the genus *Natrix* in Mexico, but considerable information on ecology and natural history is also included. Among the three species, *Natrix valida* occurs in western Mexico, but *Natrix erythrogaster* and *Natrix rhombifera* not only inhabit eastern Mexico but also range widely in the United States.

In the arid northern portions of Mexico these snakes are confined to the rivers and occasional springs and swamps, and the populations occupying individual drainage systems were formerly completely isolated from those of other systems. Theoretically it is now possible in a few areas, however, for semiaquatic snakes, such as *Natrix*, to move from one river system to another by following the canals of recently developed irrigation projects. Isolation has been of sufficiently long duration to permit the evolution of two distinct subspecies of *Natrix erythrogaster*, one each in the Río Nazas and Río Aguanaval. A third race of *erythrogaster* occurs in northeastern Mexico.

Natrix rhombifera, which also has three subspecies in Mexico, ranges widely through the lowlands of eastern Mexico. One race occurs in the northeastern states, a second has its center of abundance in the vast and complex drainage system that discharges into the Gulf of Mexico through the Río Pánuco at Tampico, and the third is widespread through the swamplands of southern Veracruz and Tabasco. The distribution of the collecting localities, when plotted on a map of the drainage systems, indicates that stream piracy probably has occurred in Nuevo León and that the Río San Juan has decapitated the headwaters of the Río San Lorenzo of the Río Conchos-San Fernando system, with consequent transfer of the aquatic and semiaquatic faunas to the drainage of the Rio Grande. The break between the two southern races of *rhombifera* occurs in the region where the Sierra Chiconquiaco and associated highlands extend eastward to the Gulf of Mexico, south of Nautla, Veracruz, and effectively separate the Gulf coastal plain into northern and southern sectors.

On the west coast there is a similar, but less massive disruption of the coastal plain immediately south of San Blas, Nayarit. Three races of *Natrix* come together in this area. One occurs northward as far as the Río Yaqui in Sonora; a second ranges southward along the tenuous and frequently interrupted coastal plain at least to the vicinity of Acapulco, Guerrero; and the third occupies an outlier of the Mexican *altiplano* in the vicinity of Tepic, Nayarit. A fourth race of *valida* is confined to the Cape Region of Baja California.

The present distribution of the genus *Natrix* in Mexico suggests that these reptiles were much more widely distributed during one or more pluvial periods of late Pleistocene or Recent time and that increasing aridity in western North America has resulted in the fragmentation of their ranges and the establishment of numerous isolated populations, especially in rivers in the northern part of Mexico. Earlier pluvial periods may also have permitted *Natrix valida* to range northward around the head of the Gulf of California and from there southward through Baja California, which would explain the presence of the isolated subspecies that has survived in the Cape Region.

The various taxa are discussed in detail in the present paper, with emphasis on variation in scutellation and color patterns. Distributions are plotted on a series of six maps. Ten plates, two in color, illustrate all the various subspecies from life; 12 additional plates illustrate habitats in which these reptiles have been collected.

Field work in Mexico was conducted in each of 10 different years, and the total accumulated time, including work on parallel studies on garter snakes of the genus *Thamnophis*, amounted to almost exactly a full year. During these investigations every state and territory in Mexico was visited at least once, as well as the Federal District.

RESUMEN

La distribución geográfica y la variación morfológica de las tres especies mexicanas de culebras aquáticas del genero *Natrix* feuron estudiadas. También se describe la ecología e historia natural de estas especies. De las tres, *Natrix valida* ocurre en la parte occidental de México, y *N. erythrogaster* y *N. rhombifera* no solo habitan la parte oriental de México, pero también su distribución se extiende al territorio de los Estados Unidos del Norte.

En las zonas áridas del norte de México estas culebras están limitadas a los ríos, ciénegas, y riachuelos. Las poblaciones que ocupan ciertas cuencas de ríos se encontraban geográficamente aisladas en el pasado. En teoría es posible que hoy en día las poblaciones de algunas cuencas puedan pasar de una sistema de cuencas a otra siguiendo los canales de riego que se han construido. El aislamiento ha sido tan prolongado como para permitir la evolución de dos subespecies distintas de *N. erythrogaster*, una en la cuenca del Río Nazas, y otra en la del Río Aguanaval. Una tercera raza de *erythrogaster* existe en el noreste de México.

Natrix rhombifera, que también tiene tres subespecies en México, está ampliamente distribuida en las terras bajas del oriente de México. Una raza existe en los estados del noreste, la segunda tiene su mayor abundancia en la extensa y compleja cuenca que desemboca por el Río Pánuco al Golfo de México en Tampico. La tercera tiene amplia distribución en las ciénegas del sur de Veracruz y en Tabasco. La distribución de localidades de colecta, cuando se trazan en un mapa de cuencas, indica que "stream piracy" ha ocurrido probablemente en Nuevo León y que el Río San Juan ha capturado la cabecera del Río San Lorenzo de la sistema del Río Conchos-San Fernando. Esto ha tenido como consecuencia que las faunas acuáticas y semiacuáticas de estos ríos han invadido el Río Bravo del Norte. El hiatus entre las dos razas meridionales de *rhombifera* ocurre donde la Sierra Chiconquiaco y las tierras altas asociadas se extienden hacia el este al Golfo de México (al sur de Nautla, Veracruz) y en efecto dividen la planicie costera en un sector meridional y un sector norteño.

En la costa occidental existe una interrupción similar, pero menor, de la planicie costera al sur de San Blas, Nayarit. Tres razas de *N. valida* se unen en esta región; una se encuentra al norte hasta el Río Yaqui en Sonora; otra se extiende al sur por la tenuosa e interrumpida planicie costera por lo menos hasta cerca de Acapulco, Guerrero; la tercera ocupa una extensión del antiplano de México en las regiones de Tepic, Nayarit. Una cuarta raza de *valida* está limitada a la región de Cabo San Lucas en Baja California.

La distribución actual del genero *Natrix* en México indica que estos reptiles tenían una distribución mas amplia durante alguna de las épocas pluviales del Pleistoceno y el Reciente. También indica que el crecimiento de las zonas áridas en el occidente del continente ha causado la fragmentación de los rangos de distribución originales y la formación de poblaciones aisladas, particularmente en los ríos del norte de México. Epocas pluviales pueden haber permitido la extensión hacia el norte de *N. valida*. Esta extensión hubiera permitido la invasión de Baja California por la costa norte del Golfo de California y por lo tanto explicaría la posición actual de la población aislada en la región de Cabo San Lucas.

La distintas unidades taxonómicas son discutidas en detalle en este artículo con énfasis en la variación de las escamas y colorido. Las distribuciones geográficas están indicadas en seis mapas. Diez paginas de ilustraciones (dos en color), hechas de animales vivos, muestran todas las subespecies. Adicionalmente se agregan veinticinco fotografías del habitat donde se han colectado estos animales. El trabajo de campo en México se hizo durante diez años, y el tiempo total (incluyendo un estudio paralelo del genero *Thamnophis*) pasado en México fué un año. Durante estas investigaciones todos los estados y territorios de México, incluyendo el Distrito Federal, fueron visitados.

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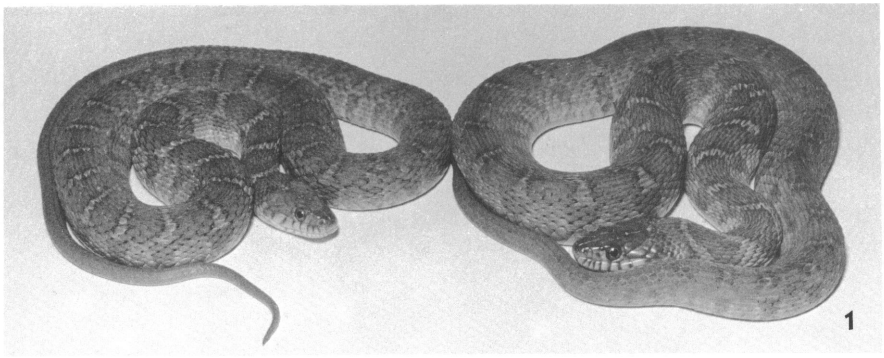

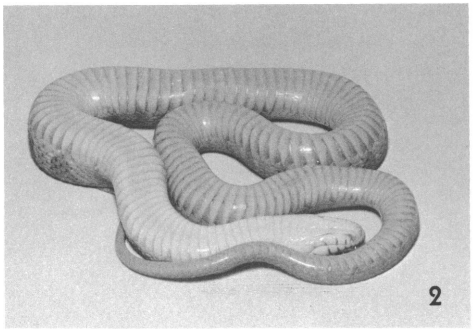

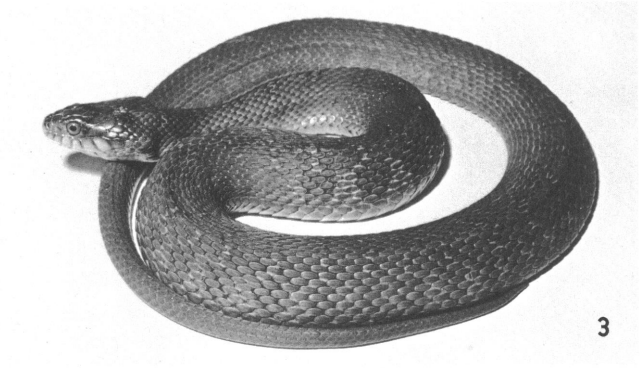

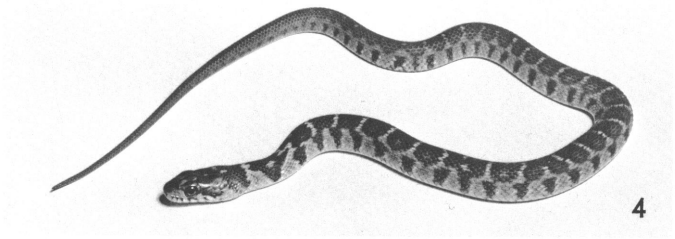

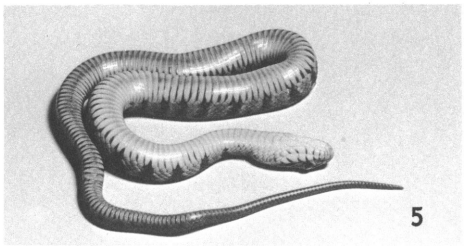

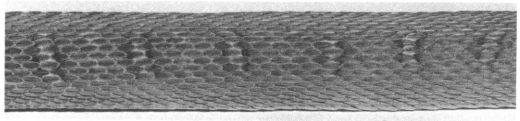

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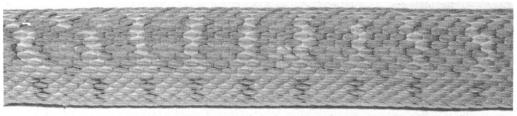
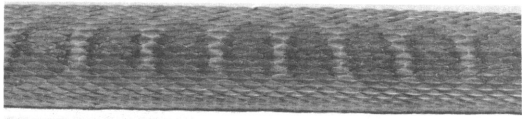
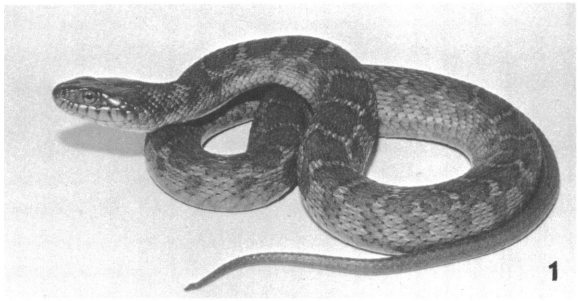
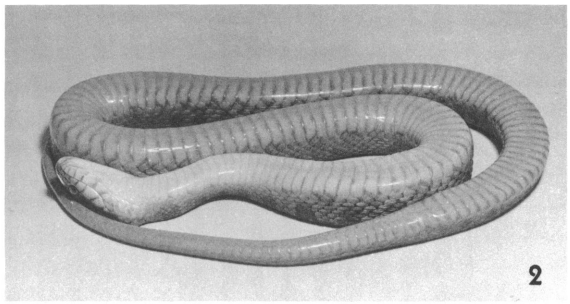
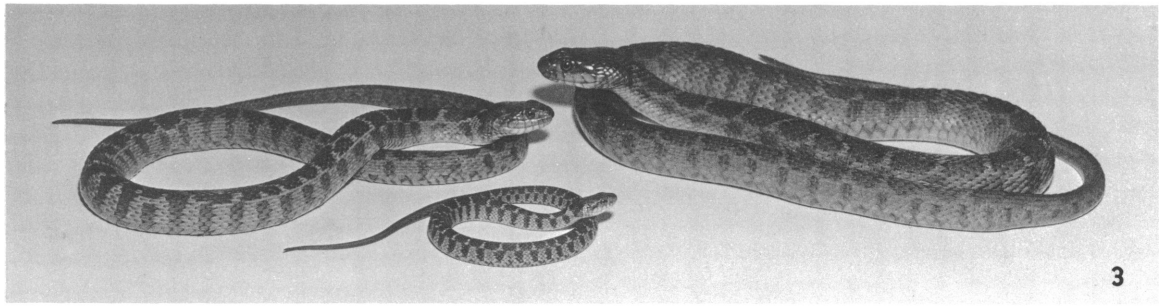


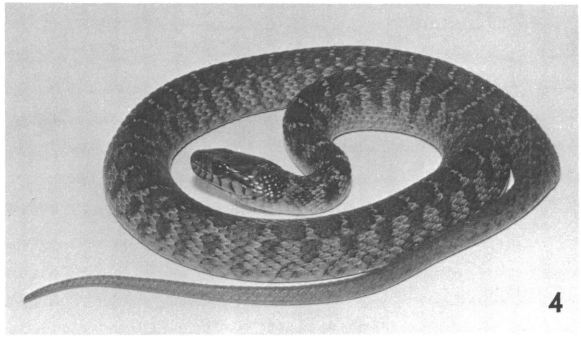


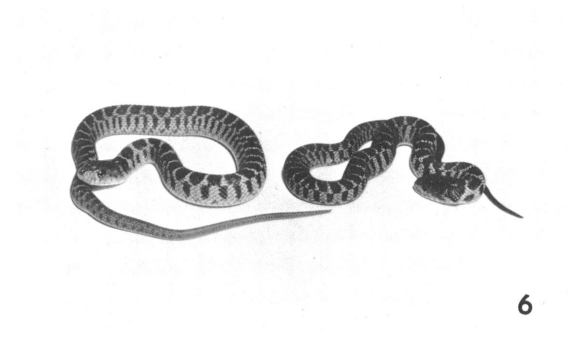
Color patterns in *Natrix erythrogaster transversa* and comparison of dorsal markings with those of other Mexican races of *erythrogaster*. 1–5. *N. e. transversa*. 1. (*Left*) Male, A.M.N.H. No. 85204, 754 mm., and (*right*) female, A.M.N.H. No. 85203, 794 mm.; both from Río Sabinas near San Juan de Sabinas, Coahuila. 2. Ventral view of male. 3. Female, A.M.N.H. No. 88950, 1101 mm.; Cañon de la Huasteca near Santa Catarina, Nuevo León. 4, 5. Juvenile, 281 mm., born to a female from Ojo de Agua, 4 miles west of Sabinas Hidalgo, Nuevo León. 4. Dorsal view. 5. Ventral view. 6–8. Dorsal views of large adults at midbody. 6. *N. e. transversa*, female, A.M.N.H. No. 88950, Cañon de la Huasteca (same snake as shown in 3). 7. *N. e. bogerti*, type, female, A.M.N.H. No. 73163, Río Nazas near La Goma, Durango. 8. *N. e. alta*, type, male, A.M.N.H. No. 84152, Río Florido, 15 miles northwest of Fresnillo, Zacatecas

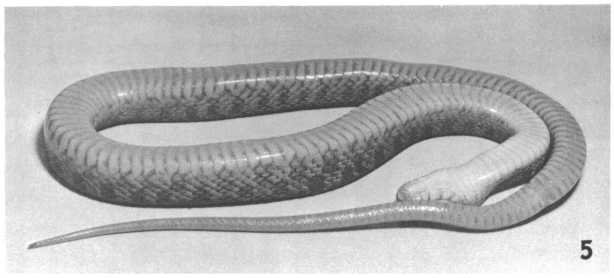




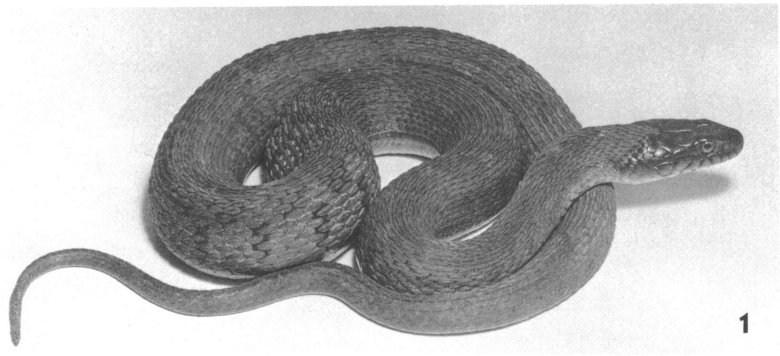


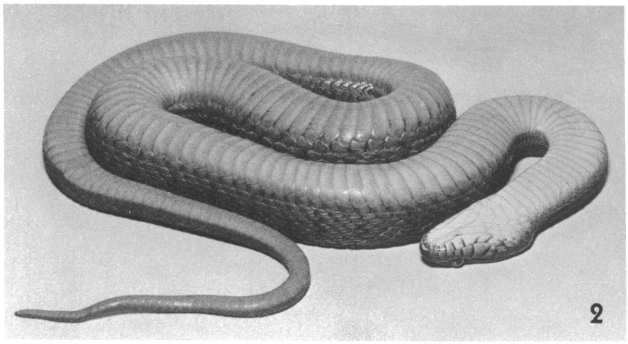


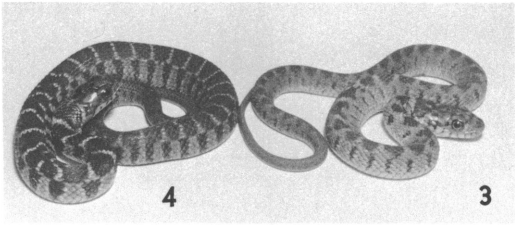


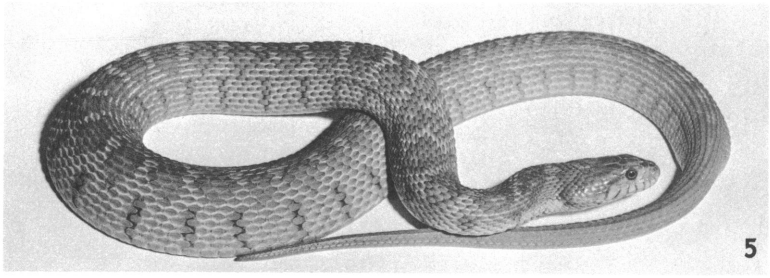


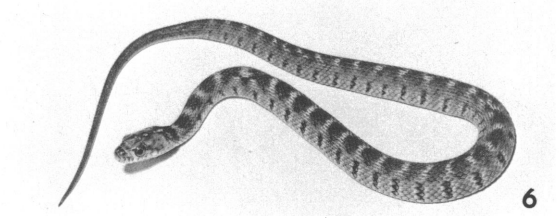
Snakes of the *Natrix erythrogaster* complex (all *N. e. transversa*) from the formerly isolated Cuatro Ciénegas *bolsón*. 1–3. Río Cañon north of Cuatro Ciénegas de Carranza, Coahuila. 1, 2. Female, A.M.N.H. No. 88757, 811 mm. 2. Ventral view. 3. Group of three freshly killed specimens, A.M.N.H. Nos. 93814, 93816, and 93817: male (*left*) 643 mm., female (*right*) 882 mm., and juvenile, 294 mm. 4–6. Pozo de Escobedo, 9 miles south of Cuatro Ciénegas de Carranza, Coahuila. 4, 5. Female, A.M.N.H. No. 89469, 889 mm. 5. Ventral view. 6. Two young, A.M.N.H. Nos. 89470 and 89471, 207 mm. and 228 mm., born to female shown in 4 and 5

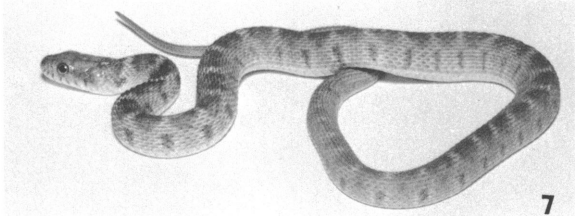




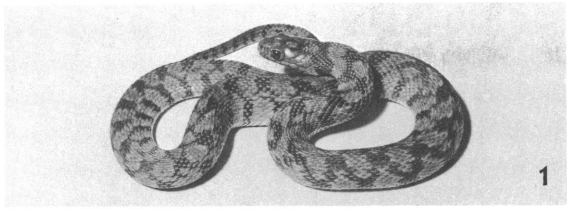


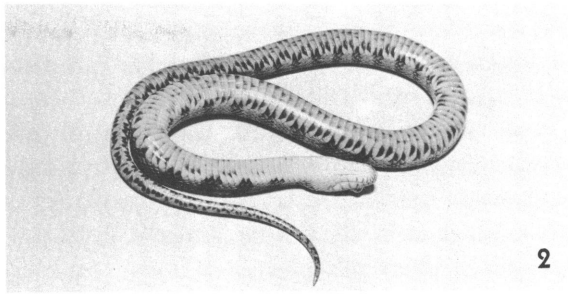


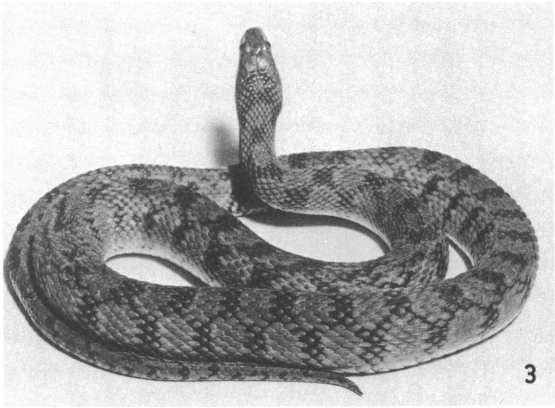


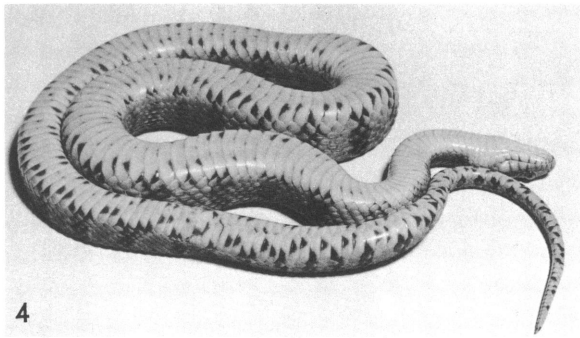


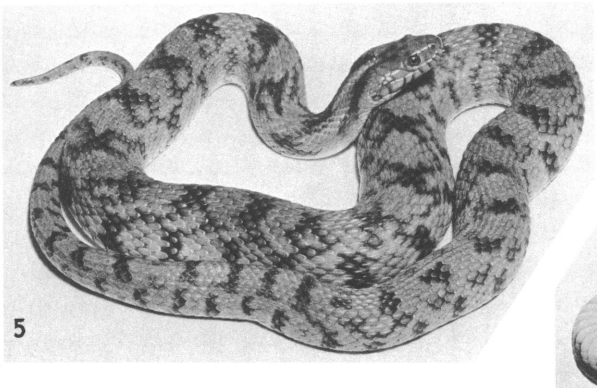
Snakes of the *Natrix erythrogaster* complex from the isolated drainage systems of the Río Nazas and the Río Aguanaval. 1–3. *N. e. alta*, Río Medina near Rancho Grande, Zacatecas. 1, 2. Female, A.M.N.H. No. 89020, 1105 mm. 2. Ventral view. 3. Juvenile, A.M.N.H. No. 89054, 263 mm. 4. *N. e. transversa* (for comparison), juvenile, 272 mm., one of a litter born to a female from the Río Salado de los Nadadores at El Cariño, Coahuila. 5–7. *N. e. bogerti*, Río Nazas near La Goma, Durango. 5. Type, female, A.M.N.H. No. 73163, 940 mm. 6. Juvenile, 300 mm. 7. Young male, A.M.N.H. No. 89453, 384 mm., in which the dark markings are beginning to fade

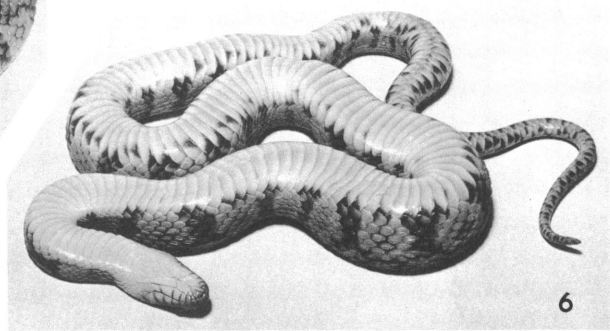




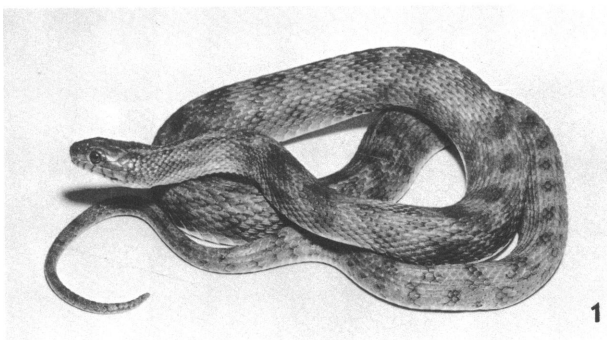


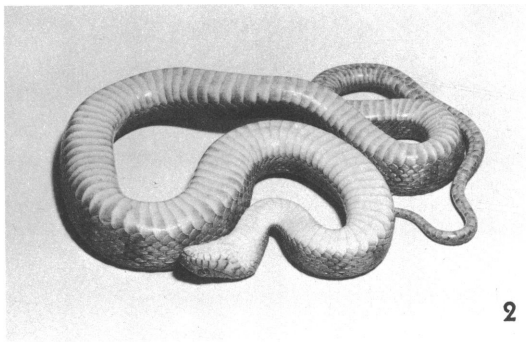


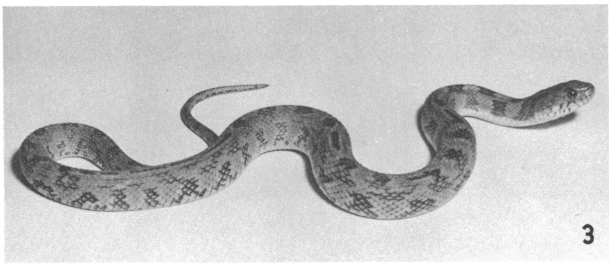


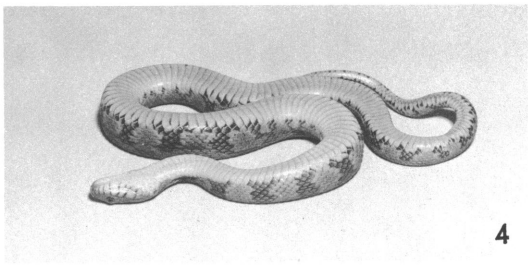


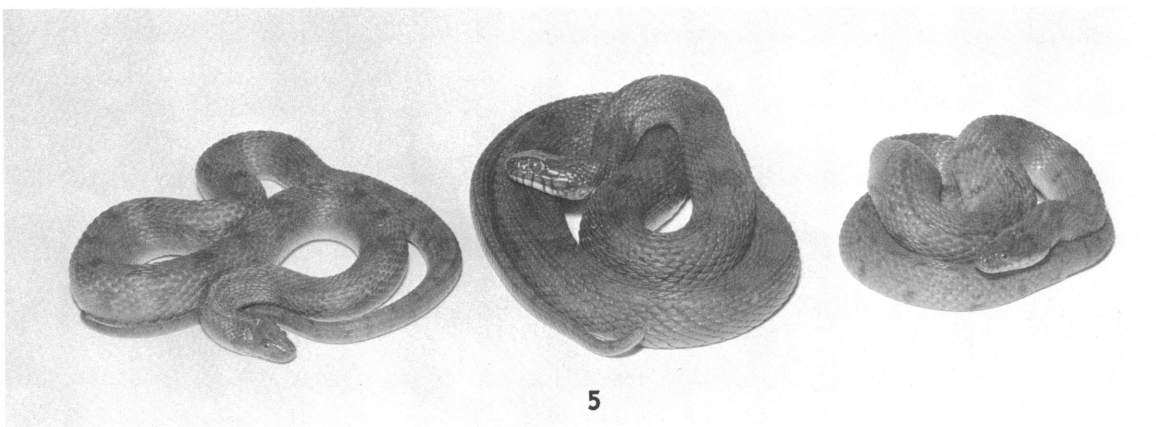
Snakes of the *Natrix rhombifera* complex from northeastern Mexico. 1–4. *N. r. rhombifera*, Ojo de Agua, 4 miles west of Sabinas Hidalgo, Nuevo León. 1, 2. Juvenile male, A.M.N.H. No. 89068, 404 mm. 2. Ventral view. 3, 4. Male, A.M.N.H. No. 89066, 875 mm. 4. Ventral view. 5, 6. *N. r. rhombifera* × *blanchardi*, Río Salinas at Ciénega de Flores, Nuevo León, male, A.M.N.H. No. 89060, 710 mm. 6. Ventral view

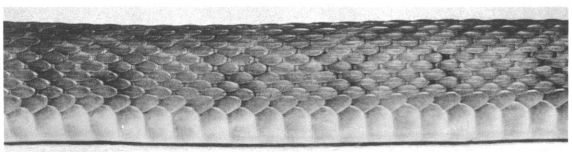


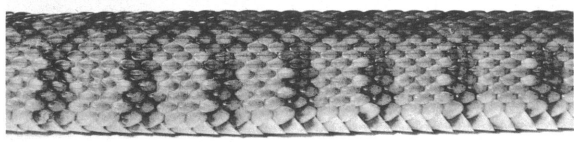




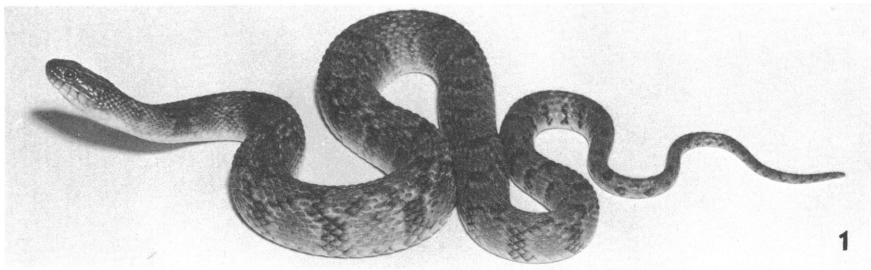


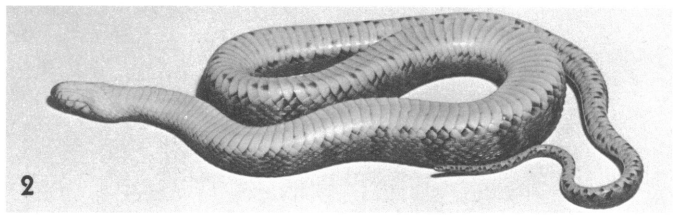


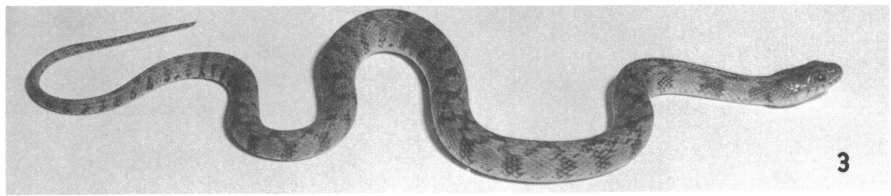


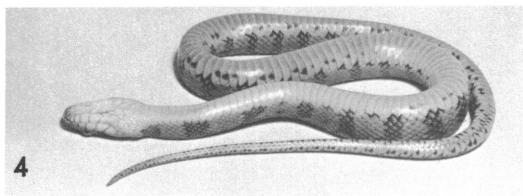


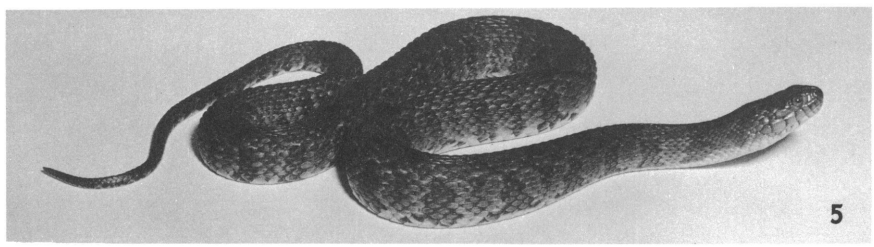
Color patterns in *Natrix rhombifera blanchardi*, and comparison of lateral markings with those of the nominate subspecies. 1–5. *N. r. blanchardi*. 1, 2. Río Guayalejo, 2 miles northeast of Llera, Tamaulipas, male, A.M.N.H. No. 89136, 896 mm. 2. Ventral view. 3, 4. Río San Fernando at San Fernando, Tamaulipas. 3. Juvenile female, A.M.N.H. No. 89484, 340 mm. 4. Ventral view of juvenile male, A.M.N.H. No. 89483, 478 mm. 5. Seventeen miles west of Tampico, Veracruz, A.M.N.H. Nos. 91111, 91112, and 91114. *Left:* Male, 705 mm. *Center:* Male, 890+ mm. *Right:* Female, 650 mm. 6, 7. Lateral views of adults near midbody. 6. *N. r. blanchardi*, Río Guayalejo, 2 miles northeast of Llera, Tamaulipas (same snake as shown in 1 and 2). 7. *N. r. rhombifera*, Ojo de Agua, 4 miles west of Sabinas Hidalgo, Nuevo León (same snake as shown in pl. 6, figs. 3 and 4)

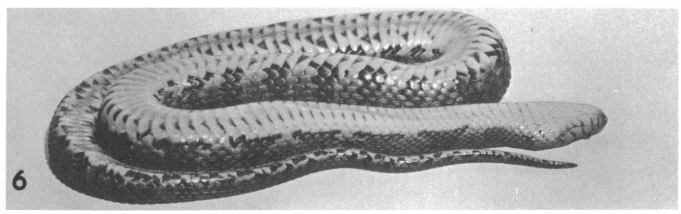




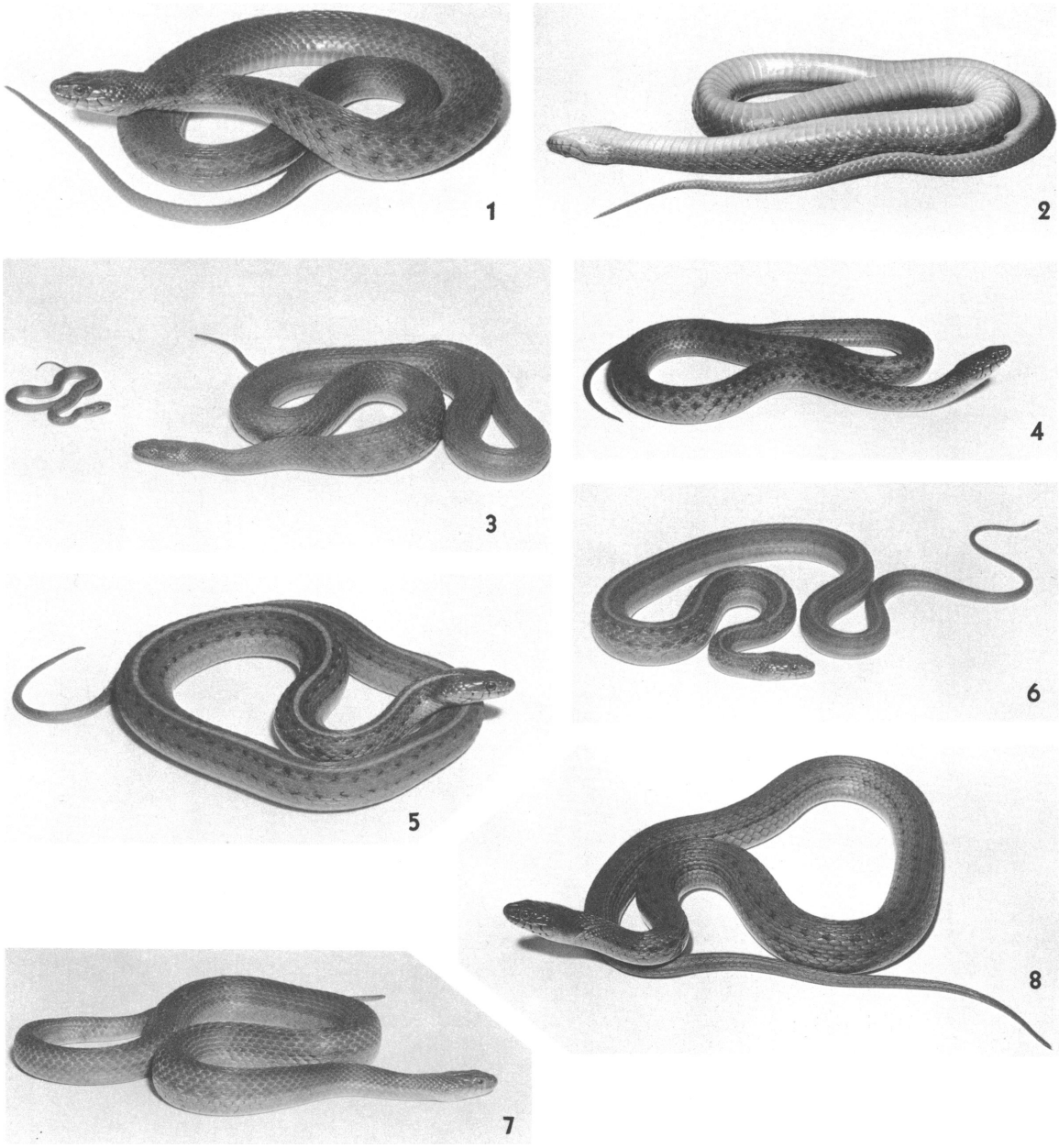




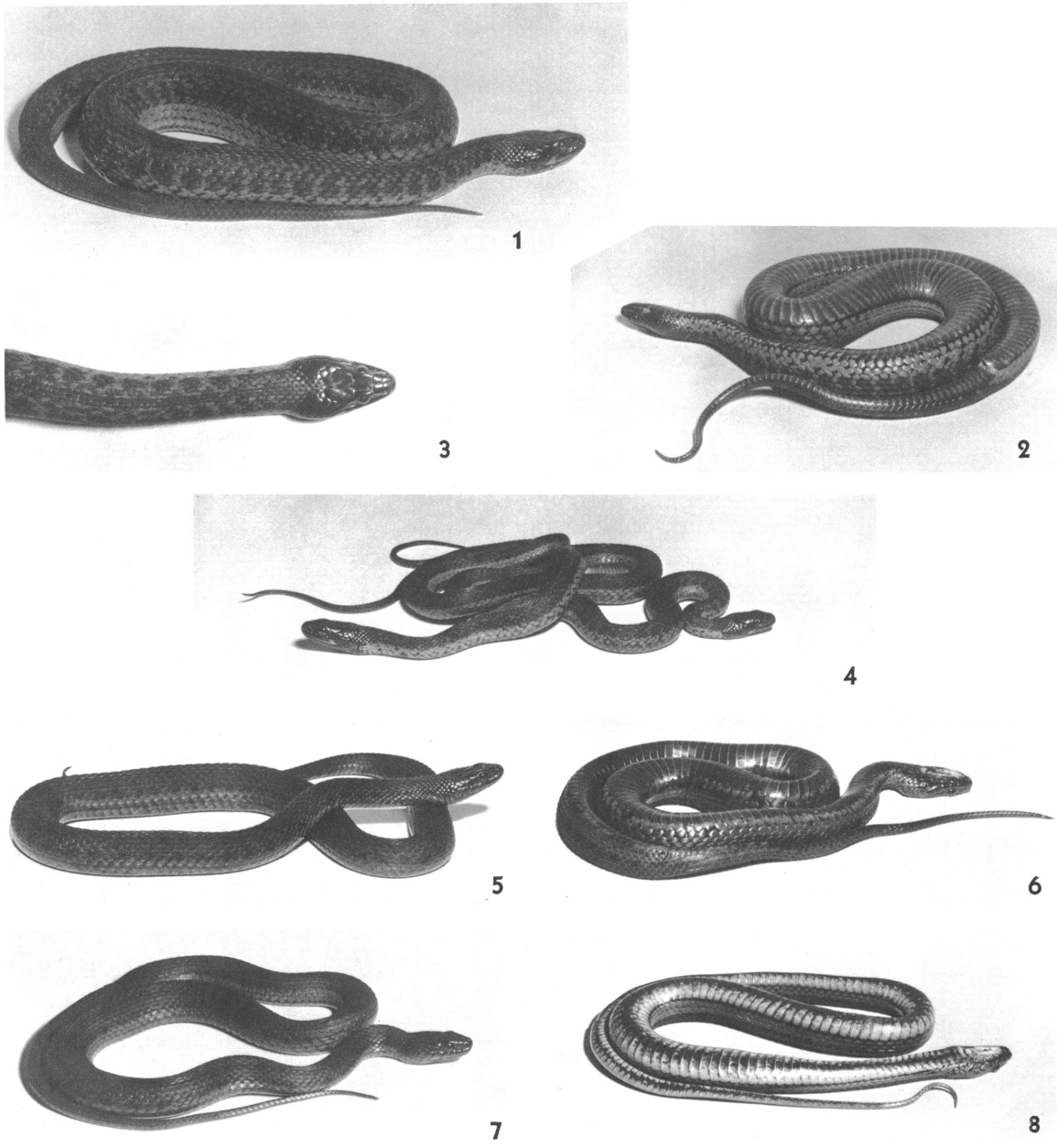




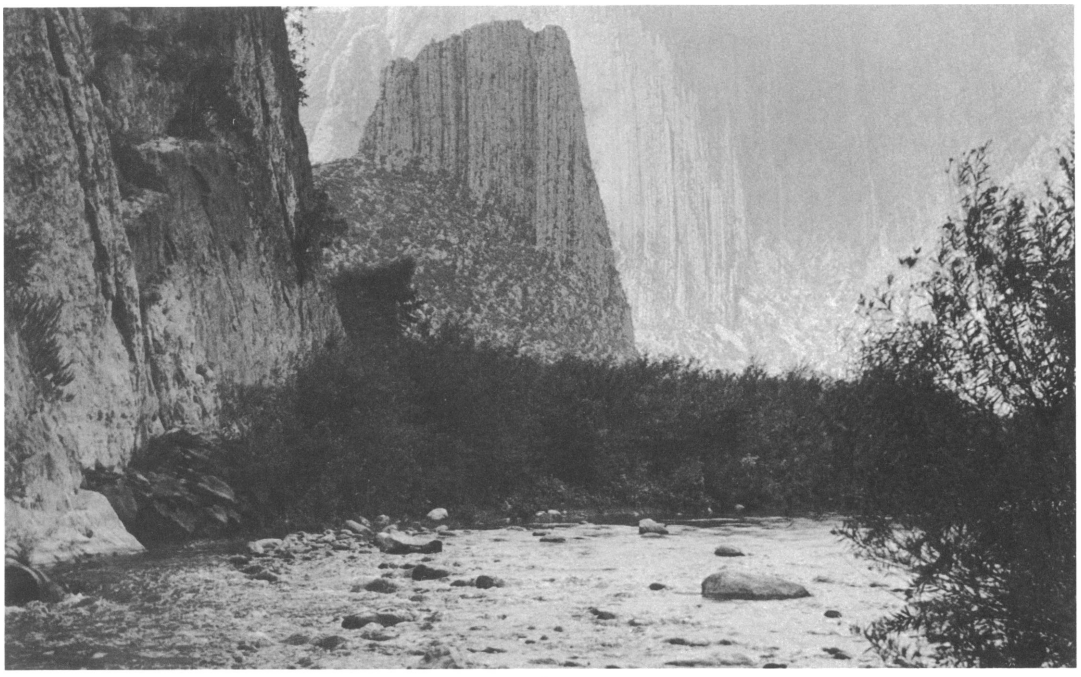
Color patterns in specimens of *Natrix rhombifera werleri* from Veracruz and Chiapas. 1, 2. 18 miles southeast of Alvarado, Veracruz, type, male, U.I.M.N.H. No. 67067, 787 mm. 2. Ventral view. 3, 4. One mile north of Cosamaloapán, Veracruz, juvenile male, A.M.N.H. No. 88792, 345 mm. 4. Ventral view. 5, 6. Playas, within 35 miles of Palenque, Chiapas, female, A.M.N.H. No. 99656, 865 mm. 6. Ventral view



Snakes of the *Natrix valida* complex from western mainland Mexico. 1–2. *N. v. valida*, Río Mayo at Navojoa, Sonora, female, A.M.N.H. No. 84075, 771 mm. 2. Ventral view. 3. *N. v. valida*, Río Fuerte, north of Los Mochis, Sinaloa, male, A.M.N.H. No. 84078, 725 mm., and juvenile, 225 mm. 4. Member of an intergrading population, *N. v. valida* × *isabelleae* × *thamnophisoides*, near Rosamorada, Nayarit, female, A.M.N.H. No. 84086, 544 mm. 5, 6. *N. v. thamnophisoides*, Puente San Cayetano, 3.5 miles southeast of Tepic, Nayarit. 5. Type, female, A.M.N.H. No. 84091, 605 mm. 6. Male, A.M.N.H. No. 84093, 523 mm. 7. *N. v. isabelleae*, 9 miles northeast of La Huerta, Jalisco, male, A.M.N.H. No. 94645, 621+ mm. 8. *N. v. isabelleae*, Laguna Coyuca, Pie de la Cuesta, 8 miles northwest of Acapulco, Guerrero, type, female, A.M.N.H. No. 73171, 814 mm.



Snakes of the *Natrix valida* complex from the Cape Region of Baja California and from near San Blas, Nayarit. 1–4. *N. v. celaeno*, near Presa El Chorro, Agua Caliente, Territorio Sur de Baja California. 1, 2. Female, A.M.N.H. No. 94600, 871 mm. 2. Ventral view. 3. Female, A.M.N.H. No. 94601, 799+ mm., dorsal view of head and neck. 4. Juvenile females, 371 mm. and 435 mm. 5–8. Melanistic members of an intergrading population, *N. v. valida* × *isabelleae* × *thamnophisoides*, 2 miles east of San Blas, Nayarit. 5, 6. Female, A.M.-N.H. No. 101364, 610 mm. 6. Ventral view. 7, 8. Male, U.M.M.Z. No. 118914, 538 mm. 8. Ventral view



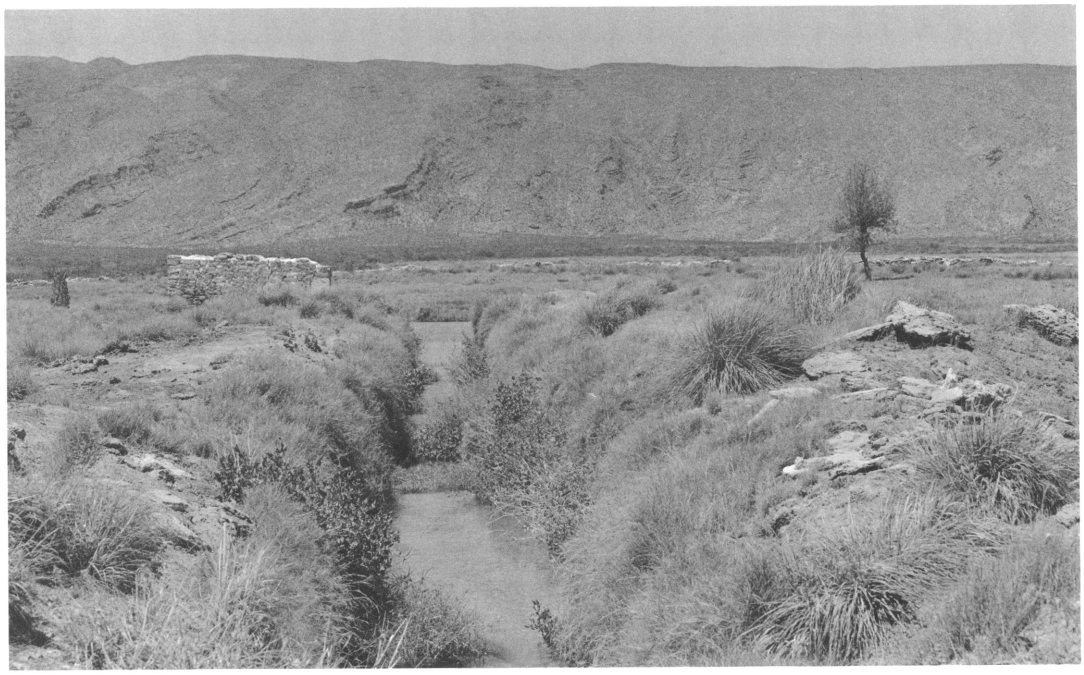
1

2

Habitats of *Natrix erythrogaster transversa*

1. Cañon de la Huasteca near Santa Catarina, Nuevo León, September 26, 1949. Several specimens were taken in shallows along the stream and in canals leading from it

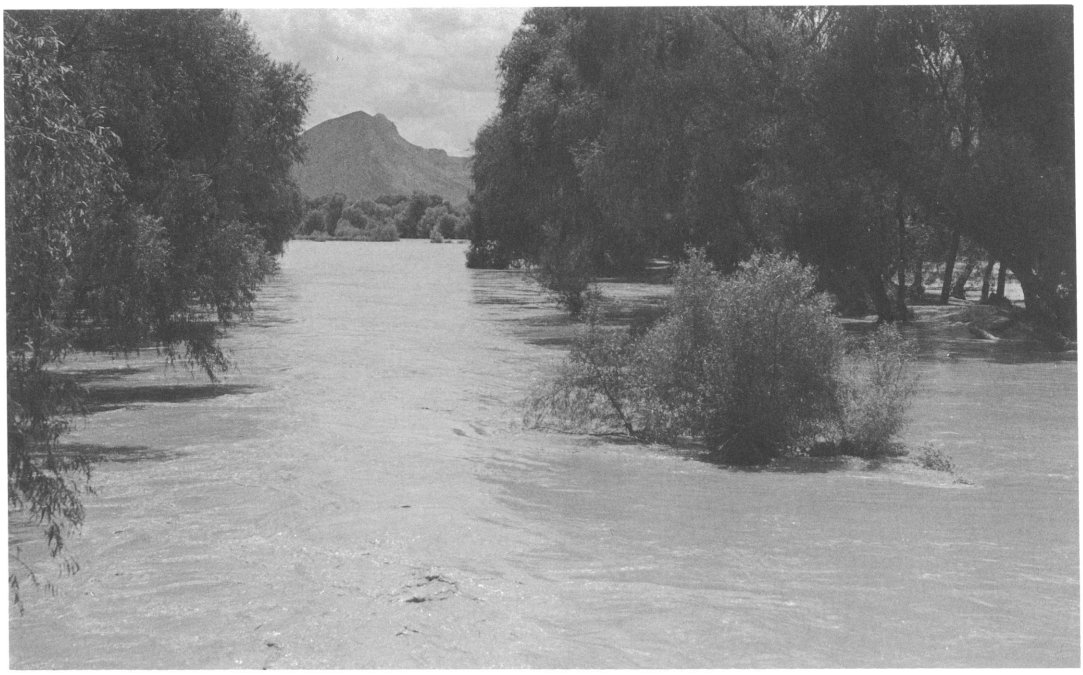
2. Río Salado de los Nadadores at El Cariño de la Montaña, Coahuila, August 22, 1964. Type locality of *Thamnophis proximus diabolicus*. *Natrix rhombifera rhombifera* also occurs in this stream



1

2

Habitats of *Natrix erythrogaster transversa* in the Cuatro Ciénegas *bolsón*
1. Ditch leading from the Pozo de Escobedo, 9 miles south of Cuatro Ciénegas, July 7, 1962
2. Río Mesquites marshes, 6 miles south of Cuatro Ciénegas, August 23, 1964

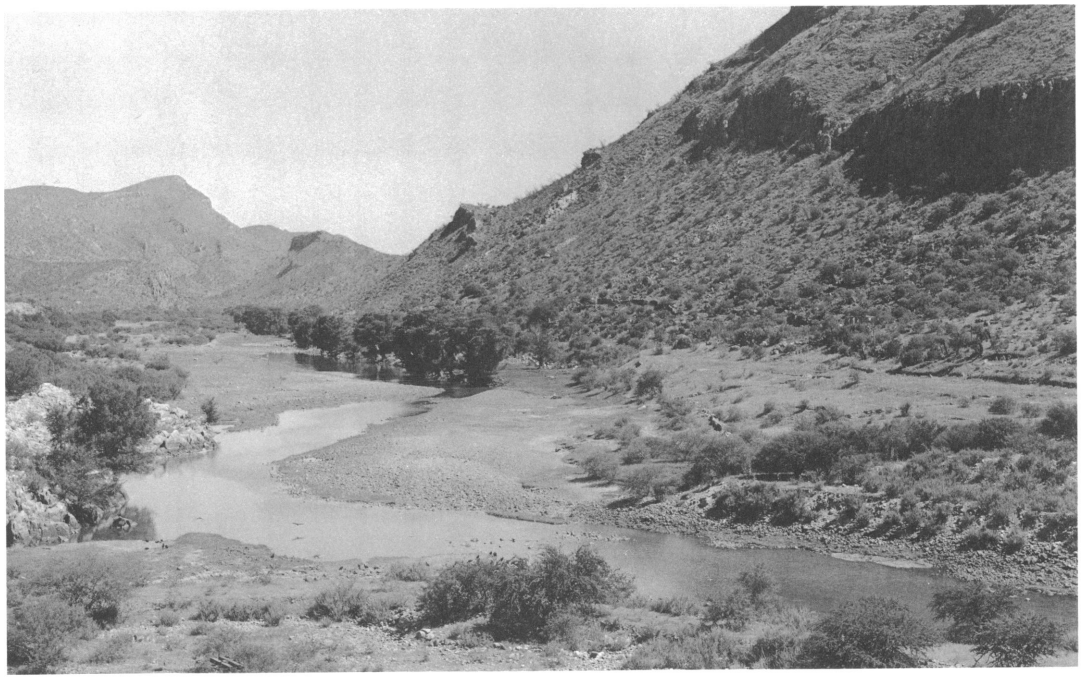


1

2

The Río Nazas, Durango, a stream of interior drainage that is the only known habitat of *Natrix erythrogaster bogerti*

1. In flood at the type locality near La Goma from the bridge on Mexico Highway No. 40, July 22, 1959
2. At low water near San Rafael, 6 miles north of Rodeo, September 30, 1961



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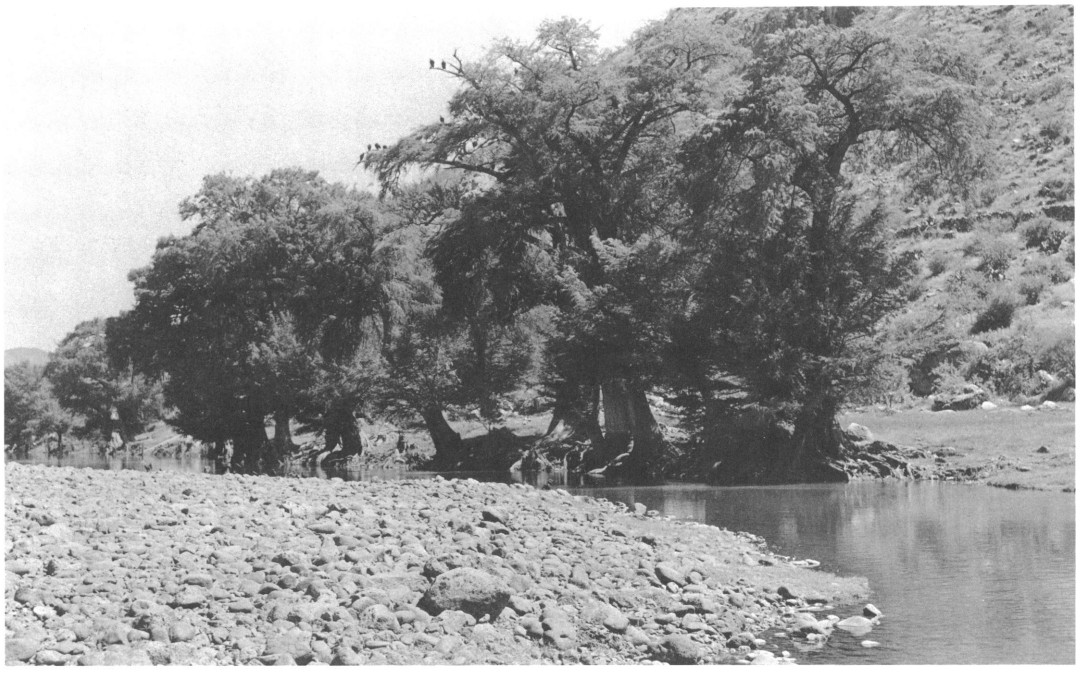
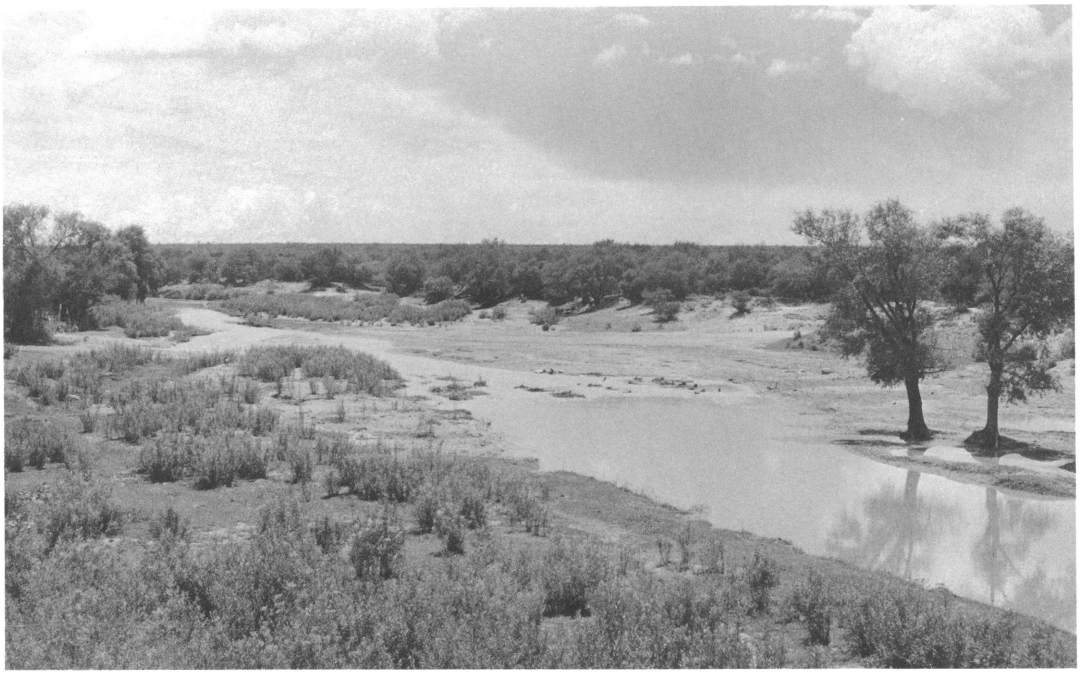


2

The Río Nazas near the Presa Cárdenas, El Palmito, Durango; both photographs taken September 12, 1960

1. A tenuous gallery forest of Mexican cypress trees in the Chihuahuan Desert
2. Close-up of gallery forest. *Natrix erythrogaster bogerti* was seen in the water near the roots of these trees

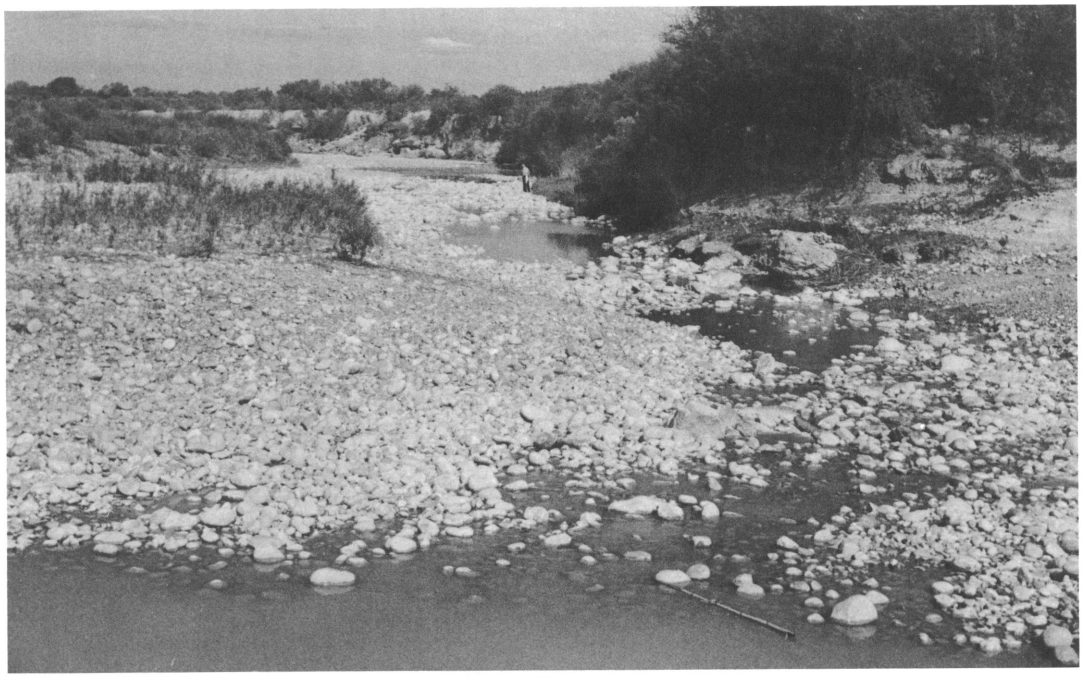


1

2

The Río Aguanaval system, Zacatecas, a stream of interior drainage that is the only known habitat of *Natrix erythrogaster alta*

1. Río Florido at Río Florido, 15 miles northwest of Fresnillo, July 19, 1959. Type locality of *N. e. alta*
2. Impoundment downstream from the village of Río Florido, July 17, 1959



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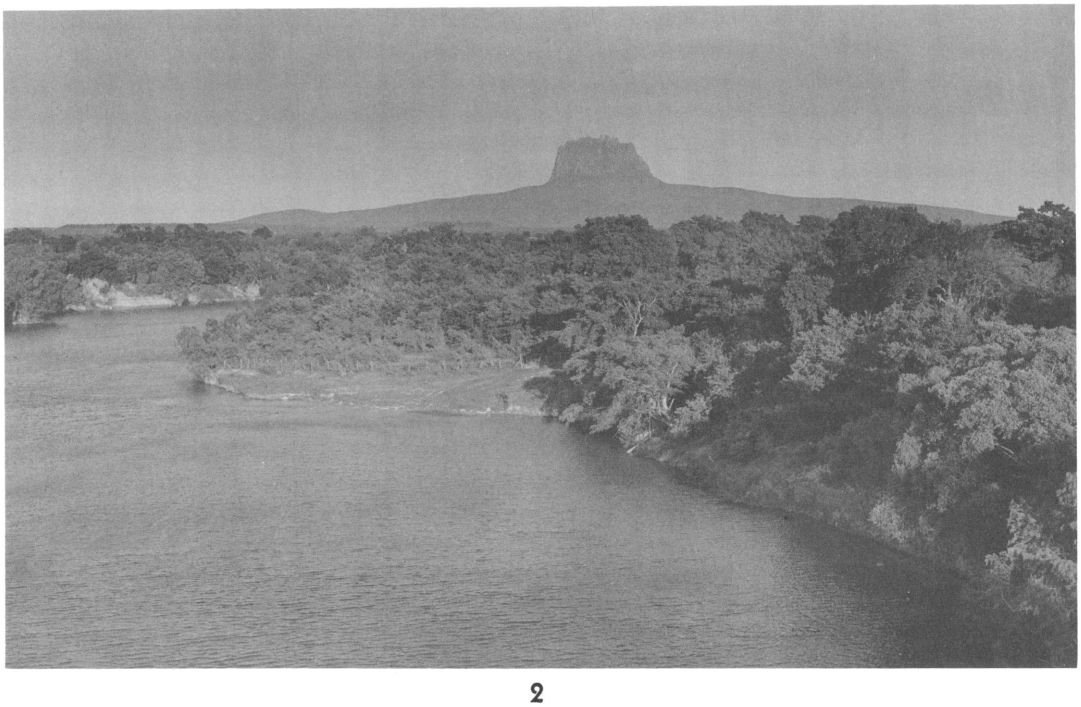


2

Habitats of races of *Natrix rhombifera* in northeastern Mexico

1. The Río Salinas at Salinas Victoria, Nuevo León, September 25, 1949. Habitat of an intergrading population, *N. r. rhombifera* × *blanchardi*

2. Río Guayalejo near Magiscatzin, Tamaulipas, with the Cerro Bernal de Horcasitas in the background, August 22, 1962. Habitat of *N. r. blanchardi*

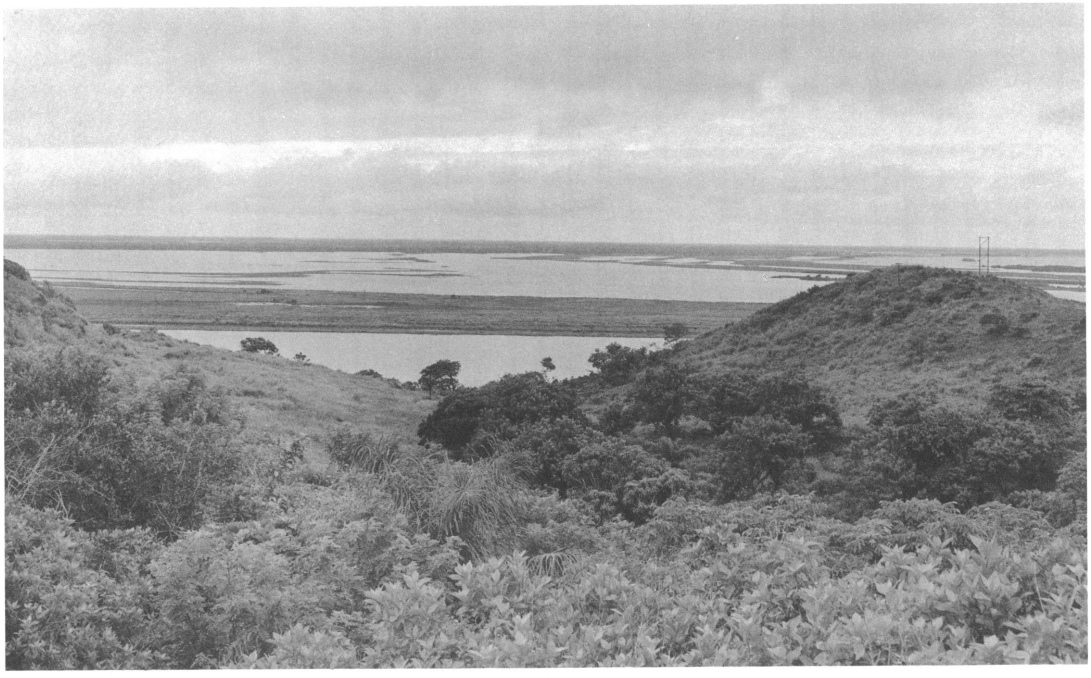
1

2

Habitats of *Natrix rhombifera blanchardi*

1. Marshes in Veracruz 17 miles west of Tampico, August 21, 1962

2. Waterway through the extensive marshes associated with the Laguna de Chairel, in Veracruz immediately west of Tampico, October 25, 1949



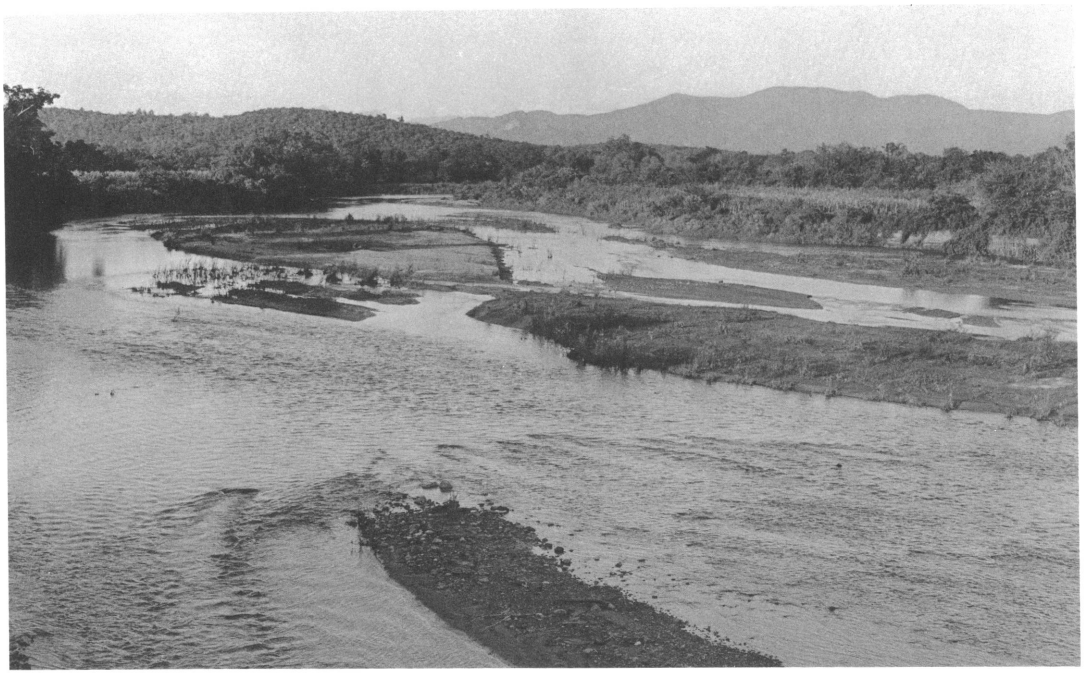
1

2

Habitats of *Natrix rhombifera werleri*

1. Río Papaloapan near Buena Vista, Veracruz, with sand dunes in the foreground, July 29, 1962. This is part of the delta region associated with the Laguna de Alvarado

2. Marshes north of Macultepec, northeast of Villahermosa, Tabasco, August 3, 1962



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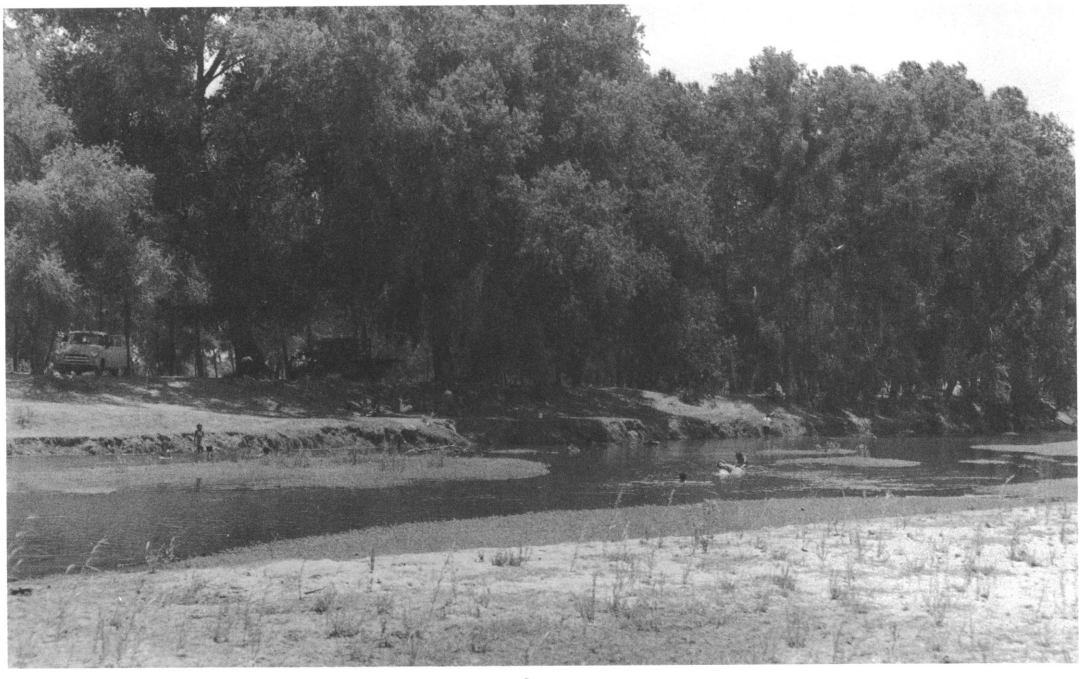
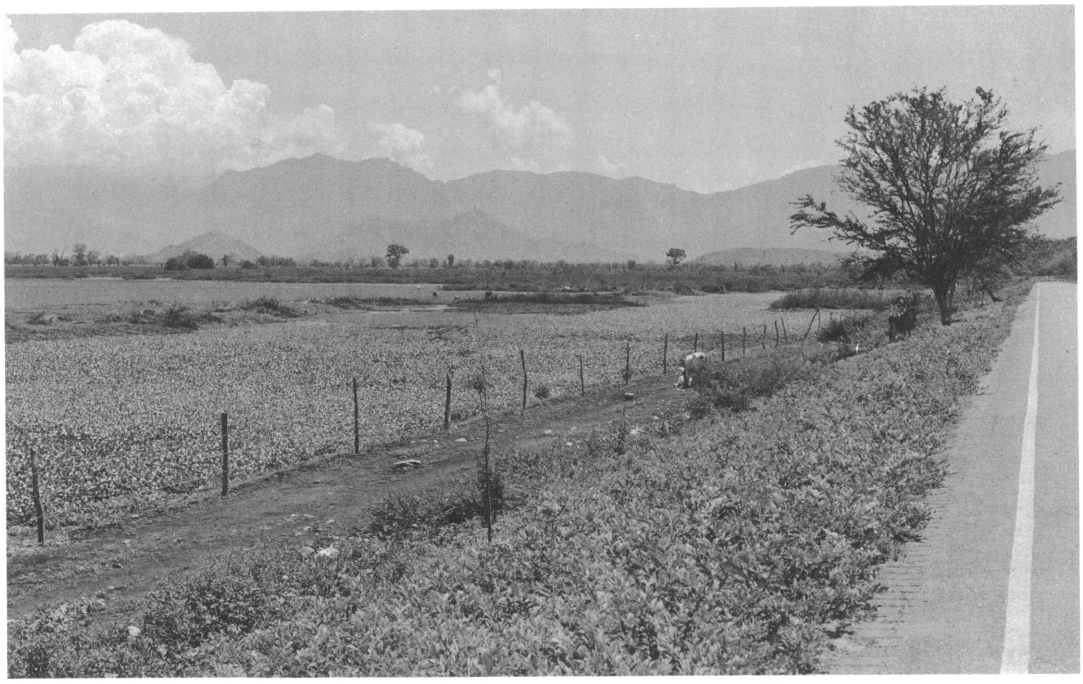


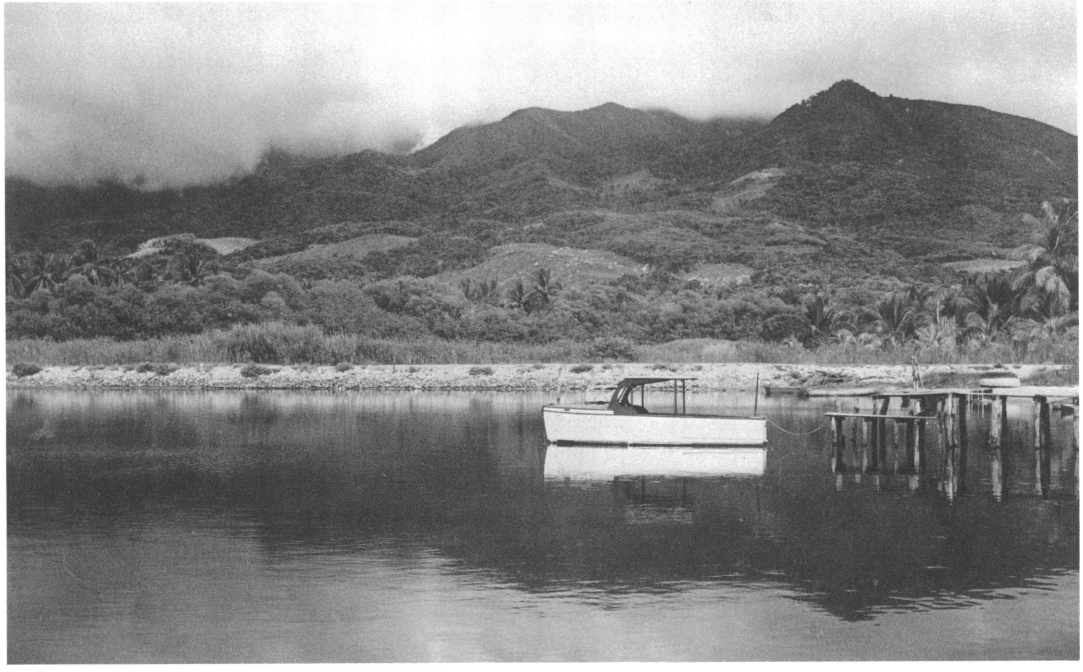
2

Habitats of *Natrix valida valida*

1. Río Quelite near Quelite, Sinaloa, with flood waters receding, September 24, 1961
2. Río Mayo near Navojoa, Sonora, June 28, 1959. Snakes were found in the river at this locality during the previous evening



1

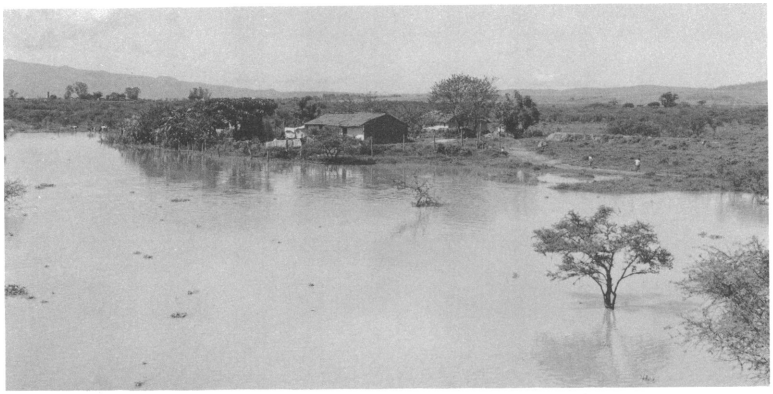


2

Habitats of *Natrix valida isabelleae*

1. Shallow swamp filled with water hyacinths along the highway approximately 9 miles northeast of La Huerta, Jalisco, July 22, 1965

2. Laguna Coyuca at the Pie de la Cuesta, 7 miles northwest of Acapulco, Guerrero, October 8, 1949. Snakes were taken along the shores of the lake, especially in marshy areas



1

2

3

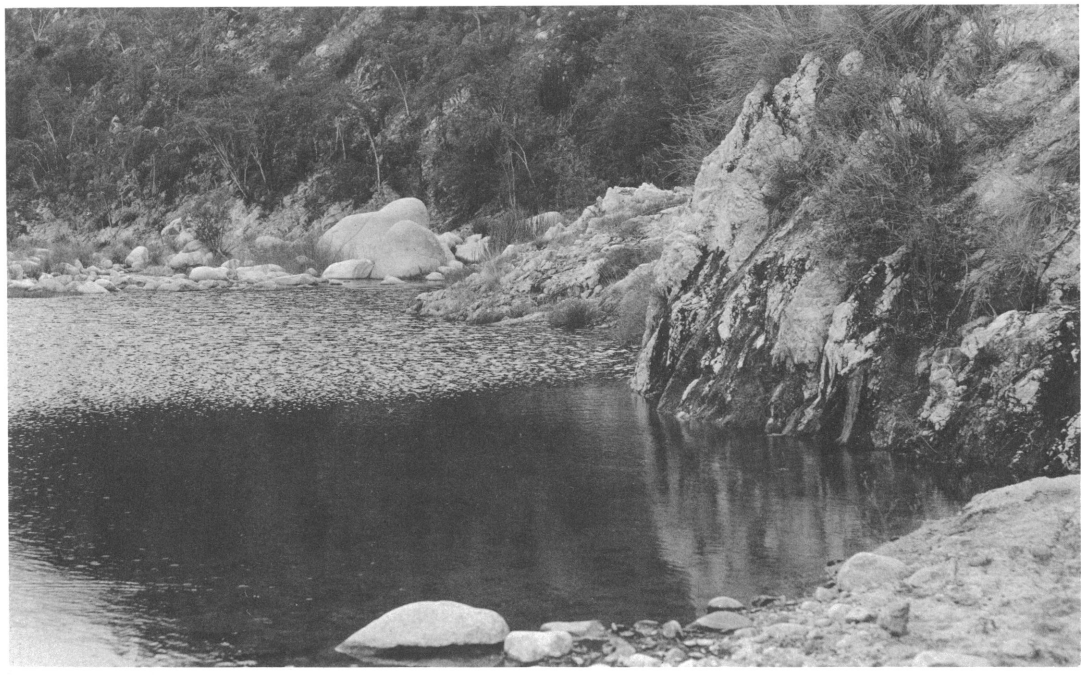
Type locality of *Natrix valida thamnophisoides*

1. Río San Cayetano at Puente de San Cayetano, 3.5 miles southeast of Tepic, Nayarit. River in flood, July 3, 1959

2. Same view with water receding, July 7, 1959

3. Small riffle in marshy meadow a short distance to the right of the area depicted in 1 and 2, September 2, 1961. Several snakes were found lying in such riffles in late morning

1



2

Habitats of *Natrix valida celaeno;* both photographs taken September 14, 1961

1. Canal near the village of Agua Caliente, Territorio Sur de Baja California. Several snakes were collected in the canal, and one was sunning in the pile of brush depicted

2. Impoundment formed by the Presa El Chorro, near Agua Caliente