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WOODPECKERS (AVES, PICIDAE)

LESTER L. SHORT

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ABSTRACT

THE BEHAVIOR of Asian woodpeckers is little known, although Asia is rich in woodpeckers, with as many as 13 species sympatric at a single locality (several places in lowland Malaya). Results of field studies conducted February to May, 1972, in India, Thailand, and Malaya are reported herein. New data on the habits, and especially the vocalizations of 29 species representing 14 genera (a fifteenth Asian genus, *Sapheopipo*, is discussed in a separate publication) compose the major portion of this treatise in which I discuss the following species: *Picumnus innominatus*, *Sasia abnormis*, *Picoides moluccensis*, *P. canicapillus*, *P. macei*, *P. cathpharius*, *P. darjellensis*, *Celeus* (*Micropternus*) *brachyurus*, *Dryocopus javensis*, *Picus miniaceus*, *P. puniceus*, *P. chlorolophus*, *P. mentalis*, *P. flavinucha*, *P. vittatus* (including *viridanus*), *P. squamatus*, *P. canus*, *Dinopium rafflesii*, *D. javanense*, *Chrysocolaptes lucidus*, *Gecinulus viridis*, *Blythipicus rubiginosus*, *B. pyrrhotis*, *Reinwardtipicus* (*Chrysocolaptes*) *validus*, *Meiglyptes tukki*, *M. tristis*, *Hemicircus*

concretus, *H. canente*, and *Mullericicus pulverulentus*. Aspects of their biology treated include foraging modes, foraging sites, displays, vocalizations and instrumental signals, breeding behavior, and habitat preference. More than 100 vocalizations and instrumental signals are described, mostly based on analysis of tape recordings. For the first time the nesting of *Dinopium rafflesii* is reported. Interspecific behavior is documented for various species, including competitive interactions between *Picoides canicapillus* and *P. macei*, between *Picus miniaceus* and *P. puniceus*, and between *Dryocopus javensis* and *Mullericicus pulverulentus*. Behavioral comparisons are made on a worldwide basis, but taxonomic implications of behavior are discussed elsewhere. A brief discussion section focuses on ecological aspects of the species studied, in particular those of variations in size, with respect to sympatry, allopatry, and ant-foraging habits.

INTRODUCTION

DURING FEBRUARY TO MAY, 1972, I was able to expand my field studies of woodpeckers representing diverse genera to include the little known, highly distinctive Southeast Asian members of the family. I observed species representing all Asian genera in varying numbers and to varying degrees. The lack of knowledge of Asian woodpeckers has been a major gap in appraising the habits and relationships of the woodpeckers of the world. The present report of my findings concerning the behavior of the species in Asia partly fills this gap. The intention of this treatise is to provide a framework and point of departure for future, diverse, comparative investigations of Asian woodpeckers and their relatives elsewhere. Particular attention is devoted to displays and vocalizations, which are apt to prove most useful for such studies.

Field studies of Asian woodpeckers commenced in early February on Okinawa in the Ryukyu Islands, where I briefly studied the endangered Okinawa Woodpecker (*Sapheopipo noguchii*). Results of investigations on Okinawa are published in Short (1973a, 1973b), and the Okinawa Woodpecker is here excluded from

detailed discussion. I spent from February 9 to March 20, and March 31 to April 25 in Malaya, moving frequently and making rounds of various optimal study sites in diverse habitats. Major study sites, at which I stayed 5 to 16 days are as follows: (1) Rantau Panjang (figs. 1, 2, coastal palm scrub, second-growth, mangroves), 4 miles north of Klang, Selangor, near sea level (also Kuala Selangor on the Selangor coast north of Klang); (2) Pasoh (International Biological Program lowland rain forest study site, figs. 3, 4), 16 miles north-northeast of Kuala Pilah, Negeri Sembilan, elevation 350 feet; (3) Ulu Gombok Forest Preserve (lowland hill forest, bamboos), 15 road miles northeast of Kuala Lumpur, 800 feet elevation (also higher, see figs. 5, 6); (4) Krau Game Reserve, Kuala Lompat (lowland primary forest), Pahang, elevation about 150 feet; and (5) Fraser's Hill (montane forest), Selangor-Pahang border, elevation 4100 feet (fig. 7). Shorter periods were spent in diverse habitats between these major sites and elsewhere in western Malaya. From March 21 to 30 my time was devoted to field work in northern peninsular Thailand. One



FIG. 1. Mangroves, coastal western Malaya at Rantau Panjang. Habitat of *Picus vittatus*, *Dinopium javanense*, *Picoides moluccensis*, and *Chrysocolaptes lucidus* (uncommon).



FIG. 2. Open palms with scattered coastal scrub woods, coastal western Malaya at Rantau Panjang. Habitat of *Picus vittatus*, *Dinopium javanense*, *Celeus brachyurus*, and *Picus miniaceus* (uncommon).

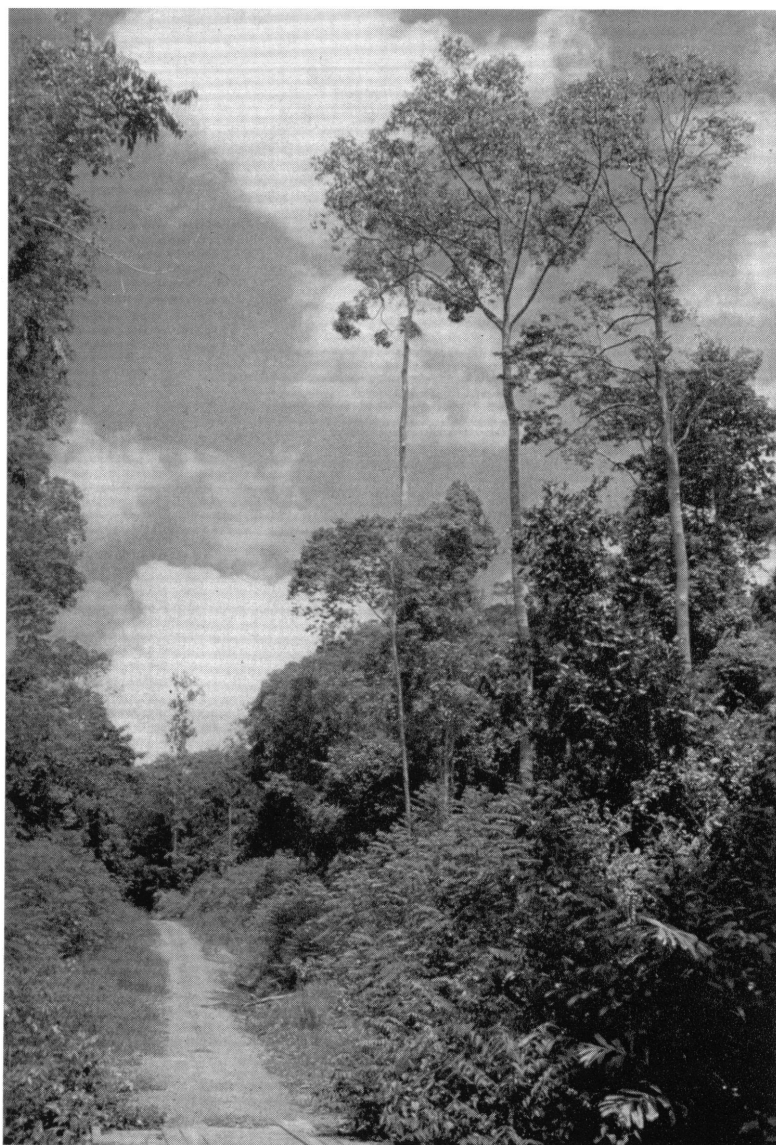


FIG. 3. Second-growth woods bordering International Biological Program Rain Forest Study Site at Pasoh, Negeri Sembilan, Malaya. Elevation about 300 ft. Woodpeckers of primary forest forage in these woods, including *Dryocopus javensis*, *Picus puniceus*, *Reinwardtipicus validus*, *Meiglyptes tristis*, *Hemicircus concretus*, and *Mulleripicus pulverulentus*.

major area worked was the region between Prachuap Khiri Khan and Huay Yang, 20 miles to the south, and inland to the base (fig. 8) of Khao Luang (elevation 4100 feet), and to the Burmese border west of Prachuap. Habitats here included coastal scrub, tree plantations, riparian

cut-over woods among cultivated fields, some dry forest at the base of Khao Luang and in patches along the Burmese border, and bamboo groves. Another site was along the Mae Nam Petburi River about 12 miles south-southwest of Petburi (elevation 150 feet), in mixed dense



FIG. 4. Lowland primary forest at Pasoh, Negeri Sembilan, Malaya (see fig. 3). View from tree platform 115 ft. above ground. Habitat of *Sasia abnormis*, *Celeus brachyurus*, *Dryocopus javensis*, *Picus miniaceus*, *P. puniceus*, *P. mentalis*, *Dinopium rafflesii*, *Blythipicus rubiginosus*, *Reinwardtipicus validus*, *Meiglyptes tristis*, *M. tukki*, *Hemicircus concretus*, and *Mulleripicus pulverulentus*.

bamboo groves (fig. 9) and second-growth forest amid cultivation. A third site was in dry scrub forest (some big trees, fig. 10) between 12 and 20 miles west-northwest of Ratburi, elevation unknown but probably about 500 feet. Some study was accomplished between these sites. Indian field studies followed. From April 28 to May 3 I was at Sukna (fig. 11), 10 miles northwest of Siliguri, West Bengal, at 800 feet elevation, in sal forest and forest plantations at the base of the Himalayas. Brief observations were made at Darjeeling (at 7000 feet), and the period of May 4 to 9 was spent in the vicinity of the Batasi Forest Rest House (figs. 12, 13) at 6900 feet, $7\frac{1}{2}$ miles west-southwest of Darjeeling and within a mile of the Nepalese border. Studies here were conducted entirely above 6900 feet, ranging upward to 9500 feet in both cut-over

forest (below 7500 feet) and primary rhododendron-oak forest.

For each species the discussion covers its geographical range, foraging habits, breeding behavior, displays, drumming, and vocalizations in that order. However, when information is fragmentary only those topics for which new data are provided will be covered. Comparisons are offered with related species where data are available, and especially with sympatric Asian species. Taxonomic applications of the data presented herein are minimal, however, as they are developed within the proper framework elsewhere. Comparative behavioral information for related and unrelated woodpeckers may be found in Short, 1970 (South America), 1971a (southern Africa), 1971b (North American *Picoides*), and 1972 (genus *Colaptes*).



FIG. 5. Hill dipterocarp forest at 2000 ft., upper Ulu Gombok, northeast of Kuala Lumpur, Malaya. Habitat of *Celeus brachyurus*, *Picus miniaceus*, *P. puniceus*, *Blythipicus rubiginosus*, and probably other lowland picids.



FIG. 6. Hill dipterocarp forest at 2200 ft., base of observation platform tree, upper Ulu Gombok, northeast of Kuala Lumpur, Malaya (see fig. 5), showing forest floor.



FIG. 7. Montane forest at 4000 ft., Fraser's Hill, Pahang, Malaya. Habitat of: *Picumnus innominatus*, *Picus chlorolophus*, *P. flavinucha*, and *Blythipicus pyrrhotis*.

METHODS

Field observations were obtained with use of 10 by 50 field glasses. Moving pictures were taken with a Bolex 16 mm. camera with various telephoto lenses, and still pictures with a Nikon Nikkormat 135 mm. camera. Movies were analyzed with a model 224 ALW Photo-optical Data Analyzer kindly lent me by Dr. W. J. Bock. Recordings were obtained with a Uher

4000 L Report Tape Recorder, operated at 7.5 inches per second together with a Uher MD 514 Dynamic microphone mounted in a 24-inch parabolic reflector. Representative sounds were analyzed using both narrow and wide band filters of a sound spectrograph (Sona-Graph, Kay Electric Co.), and representative sonagrams were chosen for illustration herein.



FIG. 8. Woodland edge at east base of Khao Luang Mountain, near Burmese border southwest of Prachuap, Thailand (elevation 300 ft.), March 26. Habitat of *Picus vittatus*, *Dinopium javanense*, and *Chrysocolaptes lucidus*.



FIG. 9. Bamboo groves southwest of Petburi, Thailand, March 28. Habitat of *Gecinulus viridis*, *Celeus brachyurus*, *Picus vittatus*, and *P. canus*.



FIG. 10. Monsoonal dry woodland west of Ratburi, Thailand, elevation 500 ft., March 29. Habitat of *Picus canus* and *Chrysocolaptes lucidus*.

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SPECIES ACCOUNTS

THE ACCOUNTS BELOW treat all Asian species studied in the field in 1972, except for the Okinawan *Sapheopipo noguchii* (Short, 1973b). Various aspects of ecology and behavior are included, as mentioned above. The systematic order follows the arrangement of Bock and Short (ms), which is being used in preparing my forthcoming book on the woodpeckers of the world.

SPECKLED PICULET

Picumnus innominatus

The Speckled Piculet essentially is a bird of hilly forest undergrowth and bamboo, occupying the area from Himalayan India and montane South China to Malaya, Borneo, and Sumatra. Although sporadically it reaches the lowlands, I did not find it there, even in forests of the lowest Himalayan slope near Siliguri, northern Bengal, India. Unlike *Sasia abnormis*, and like its Neotropical congeners, *Picumnus innominatus* is a solitary bird, occurring alone or in pairs and not in groups (except for family parties immediately after nesting). It also differs from *Sasia* and resembles *Picumnus cirratus* in being tame, by allowing close approach and not showing alarm. Foraging sites utilized by this bird are like those of *Sasia* (branchlets, bamboo, vine, shrub), but Speckled Piculets tap louder and more persistently to secure food than does *Sasia abnormis*. Nevertheless, allopatry of these piculets suggests that they may compete if sympatric. In Malaya they seem completely allopatric in distribution.

Most of my encounters with this piculet were with individuals foraging in interspecies foraging flocks. They accompanied larger mixed species flocks, and I never saw more than one piculet in a single flock. Although this piculet flies rapidly, its foraging is concentrated at rather few sites. A foraging Speckled Piculet often spent 2 to 4 minutes at a single opening, or at two openings it had made in a branchlet, then flew away in the direction of the foraging flock. Thus, concentrated effort is expended at a single site, and the piculet utilizes but one or two sites before it must depart to catch up with the moving flock. It is not known whether Speckled Piculets accompany such flocks over great distances, or only

within their own territory as for example, is the case in *Rhipidura albifrons*. In highland Malaya the mixed foraging flocks included babblers of the genera *Garrulax*, *Heterophasia*, *Alcippe*, and *Stachyris*, drongos (*Dicrurus aeneus*), flycatchers (especially *Muscicapa solitaria* and *Rhipidura albifrons*), and frequently other species (e.g., the barbet *Psilopogon pyrolophus*, the broadbill *Psarisomus dalhousiae*, and the bulbul *Hypsipetes maclellandii*).

The tapping of *Picumnus innominatus* is louder and heard more frequently than is that of *Sasia abnormis*. The bulk of its foraging appears to be by tapping, or excavating, then "tonguing" up insects through the holes they have made. A male observed at very close range on April 18 at Fraser's Hill, Malaya, tapped lightly but persistently on a dead stalk (3 meters long), apparently a small bamboo, for 12 minutes. It made four holes in the stem, and fed at each one for two or more minutes. When excavating it perched crosswise on the stem (2½ cm. diameter) with its tail held inward, but not touching the stem. Its technique was to peck from one side two or three times, swing its body around to the other side, and then deliver several more blows before shifting again. I examined the openings after the bird had left, and, on breaking the stem I found within it a discontinuous line of small red ants (sp. unknown). Another piculet foraged on a tiny (½ cm.), vertical vine, on which it perched vertically in the usual woodpecker fashion. Its tail too was appressed, but it appeared to touch the bark only occasionally.

I saw a male Speckled Piculet excavating a cavity on March 15. The next day it was still working at the opening, but when I returned on April 18, no piculets were using it. The excavation was in a hanging, almost vertical dead branch in a broken-topped, dead palm tree (sp. unknown). The palm stub was about 10½ meters tall, with the top broken, and dead fronds hanging downward; winds made these fronds sway. The frond containing the cavity was about 5 cm. in diameter at the point of excavation. The tiny opening received about four hours of vigorous excavation on March 16. The excavating bird hunched its back, moved the head far back prior to delivery, and it



FIG. 11. Partly managed (by West Bengal foresters) sal forest at 800 ft., Sukna, India, May 1. Habitat of *Picoides canicapillus*, *P. macei*, *Celeus brachyurus*, *Picus chlorolophus*, *P. flavinucha*, *Chrysocolaptes lucidus*, *Hemicircus canente*, and *Mulleripicus pulverulentus*.

appressed its tail against the bark about half the time. When appressed, the tail was strongly appressed, even spreading the rectrices to the extent that white was visible and the feather tips were bent to one side. At other times, especially when the piculet worked leaning into the hole, the tail was bent sharply inward, as if it were

being used for support, but it did not touch the substrate or even come close (1 to 2 cm.) to it. The feet were held rigidly, locked in position with the clenched toes bowed outward, not flat against the frond. The blows were delivered exactly as in larger woodpeckers, with the bill striking from either side or directly downward,



FIG. 12. Mountain forest at 8000 ft., southwest of Darjeeling, India, near Nepalese border, May 5. Habitat of *Picoides cathpharius*, *P. darjellensis*, *Picus squamatus* (open places), and *Blythipicus pyrrhotis*.



FIG. 13. Mountain forest at 8000 ft. (same as fig. 12), near Darjeeling, India, May 5. Unmanaged forest showing understory.

and with occasional pauses during which the bird picked up and tossed out wood chips accumulating in the entrance cavity. The cause of abandoning the cavity is not known, nor do I know whether it was a nesting or roosting cavity.

The only vocalization heard from this bird was an occasional sharp "tsick" call very like that of other piculets. No drumming was heard although it is well known that they drum (Smythies, 1953, p. 308).

The foraging habits and other behavior of this piculet are similar to those of South American *Picumnus cirratus* (Short, 1970), and there is no reason to separate *innominatus* generically from the New World species (see *Celeus brachyurus*, below).

RUFIOUS PICULET

Sasia abnormis

(Figure 14)

Although Rufous Piculets are not uncommon in some parts of primary forests, in dense second-growth, and in bamboo groves, these birds are exceptionally fast-moving, difficult to detect, and exceedingly difficult to observe for more than a few seconds. Most glimpses of them occur when one or several pause momentarily before darting into the forest when disturbed by a passing observer. The dense understory they prefer usually precludes a chase after them.

The Rufous Piculet often is found near water, although this may be a reflection of its preference for dense, low vegetation. Swamp forest and bamboo clumps especially are favored. This diminutive woodpecker sporadically inhabits forested lowlands and hills of Sundaland, including Malaya, and peninsular Thailand and Tenasserim, Burma. Occasionally it is found in hills up to 4000 feet in elevation (Glenister, 1951). Foraging involves tapping and gleaning from vines, bamboo, shrubbery, and small saplings near the ground. Movements are rapid and the birds often fly a considerable distance from site to site rather than methodically progressing from tree to tree. Family groups apparently remain together for long periods, as three and sometimes four birds were seen together as early as February; they are not likely to have nested within a few months prior to that. Adult birds taken in mist nets during February showed no brood patch and no sign of molt.

I encountered no nesting of Rufous Piculets

and I saw no displays. The only vocalization that I heard was the repetitive, sharp "tic" call. "A creaking note of many syllables" was reported by Robinson (1928, p. 115). These woodpeckers perch crosswise in branchlets, and they often climb by short upward flights on saplings or bamboos growing at an angle, that is, non-vertically. In these upward movements they usually reverse the direction in which they face, first perched crosswise facing left, then shifting to the right farther up the stem, etc. Individuals moved almost simultaneously from site to site, suggesting strong sociality.

Adults in February had red-violet orbital skin, orange-chestnut irides, and a bicolored bill that was entirely black above and pale yellow below.

BROWN-CAPPED WOODPECKER

Picoides moluccensis

This diminutive woodpecker of Sundaland, including Malaya, of India, and Ceylon occurs inland in the last two areas but is found only in the narrow coastal belt of Malaya. It is a sparse inhabitant of mangroves in western Malaya, where it forages quietly on branches and twigs by tapping, gleaning, prying, and probing. The foraging of the Brown-cap is not noisy, and it is difficult to detect unless it drums. Most of its food comes from the surface, or from superficial layers of the bark. One bird pried under loose bark, extricating insects from beneath it. Ali (1953) and Henry (1955) recorded diverse insects, berries, and nectar of flowers as its foods in the Indian region.

Sporadic drumming was heard in April. Dead, small stubs of taller mangrove trees are the usual drumming sites. Drumming was weak and repetitive in bouts at long intervals during the morning hours, but not in the afternoon. Bouts lasted up to five minutes, and six to eight bursts were given per minute. Four recorded drums (fig. 15a) contained 17 to 20 beats rendered in 0.58 to 0.68 second at a rate of 28.8 to 29.7 beats per second. Most sound is included between 1.3 and 2.0 kilocycles, and thus the pitch is rather higher than in many other species of its genus. However, *P. minor* of Europe drums at about the same pitch and tempo (Blume, 1968, p. 63), as does North American *P. scalaris* (Short, 1971a, p. 83). Drumming presumably functions agonistically, to proclaim territories



FIG. 14. Male Rufous Piculet (*Sasia abnormis*). Bird in hand, taken from mist net at Pasoh, Negeri Sembilan, Malaya.

and perhaps to attract the attention of the mate, but studies are necessary to establish this.

Only one vocalization was heard from three birds that I observed. The call, a very weak Rattle Call ("ti-ti-ti-ti-ti-ti"), was not recorded. The soft rattle is like that of the sympatric Gray-capped Woodpecker (*P. canicapillus*) which calls more loudly. In the field *moluccensis* appears browner, with a brown cap and a malar

stripe, compared with *canicapillus*, which is more black with no malar patch (this difference does not hold throughout the ranges of the two species) and a gray head. However, the simplest way to distinguish them in the field is by the browner, dingy appearance of *moluccensis*; *canicapillus* is more contrastingly black and white.

It is unfortunate that *moluccensis* was uncommon, and thus could not be studied in detail.

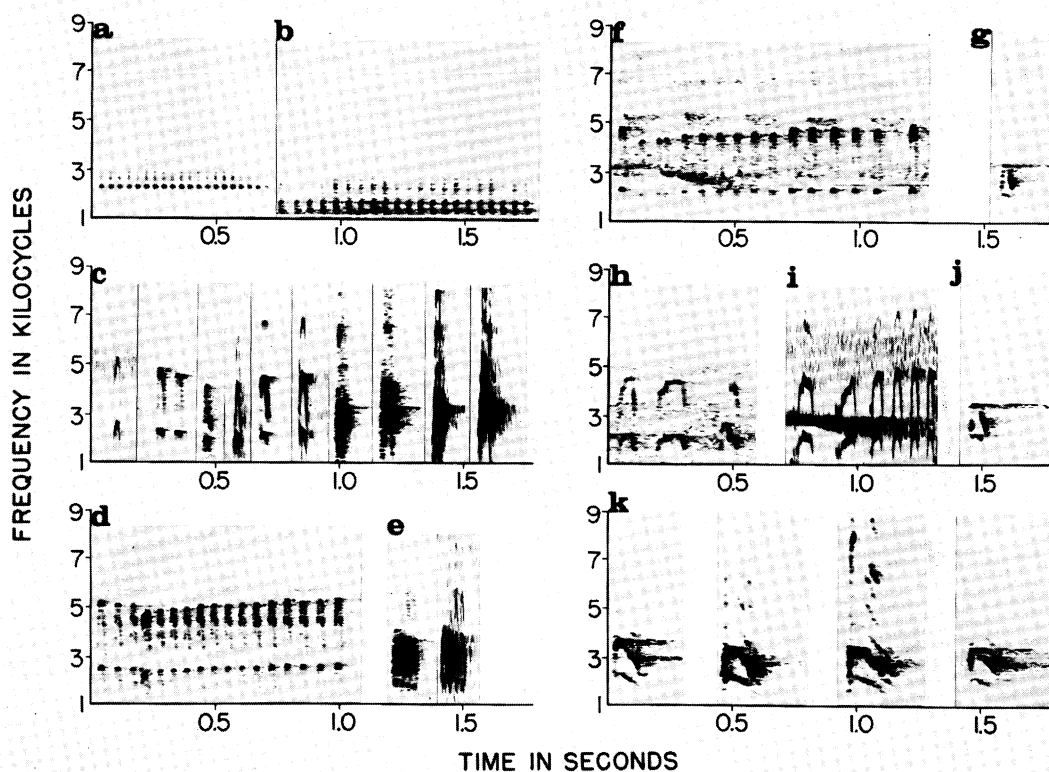


FIG. 15. Sound spectrograms of drumming and vocalizations of species of *Picoides* and *Dryocopus*. a. Drumming of *Picoides moluccensis*, Malaya. b. Drumming of *P. darjellensis*, near Darjeeling. c. Pit and Peek Calls, from left to right: Pit Call of *Picoides canicapillus*, WB; double Pit Call of *P. canicapillus*, Sukna, India; Pit Call of *P. cathpharius*, followed by same call, WB, near Darjeeling; Pit Call of *P. macei*, followed by same call, WB, Sukna, India; Peek Call of *P. darjellensis*, near Darjeeling; Peek Call of *P. syriacus*, Austria; Peek Call of *P. darjellensis*, WB; and, at right, Peek Call of *P. syriacus*, WB (compare especially *P. darjellensis* with *P. syriacus*, and *P. canicapillus* with *P. macei*, see text). d. Rattle Call of *P. canicapillus*, Sukna. e. Short Rattle Call of *P. cathpharius*, followed by same call, WB. f. Rattle Call of *P. macei*, Sukna. g. Kew Call of *Dryocopus javensis*, kuk version (see j, k below), Malaya. h. Kweek Call (part of 5-note call; note variation among notes) of *P. canicapillus*, Sukna. i. Two Kweek notes followed by initial four notes of Rattle Call of *P. canicapillus*, Sukna, WB (note resemblance of first rattle note and kweek notes; disregard horizontal loud sound at 3 kc.) j. Kew Call of *Dryocopus javensis*, kyuk version (see g above and k below), Malaya. k. Kew Call, *Dryocopus javensis*, left to right kew, kyow, kyow-kee-ow, and kee-ow versions, Malaya. Note that a, b, g, j, k should read 1 kc. lower than indicated above. See text. All sonagrams are narrow band unless indicated wide band by WB.

Investigations of *moluccensis*, and the related *temminckii* of Celebes, and *maculatus* of the Philippines would provide useful information for phylogenetic analysis of relationships within *Picoides*, and between *Picoides* and African *Dendropicos*.

GRAY-CAPPED WOODPECKER

Picoides canicapillus

This diminutive woodpecker occupies a vast range from northern India to Manchuria and Taiwan, south to Malaya, Sumatra, and Borneo.

In India it extends from the Himalayan slopes to the lowland forest at their bases. It is entirely a lowland species in Sundaland, where it is uncommon. The same mangrove forests of Malaya occupied by the Brown-capped Woodpecker are inhabited by the Gray-cap, which apparently is less common, but the latter unlike the former also extends inland sporadically. The vast areas of lowland Malaya, however, lack species of the genus *Picoides*. I saw Gray-caps in Malaya only at Kuala Selangor in scattered tall trees atop a prominent hill overlooking mangrove forest. In West Bengal this woodpecker was common in sal forest at the base of the Himalayas.

Foraging Gray-capped Woodpeckers explore the stubs of dead trees, especially the small dead stubs of live trees. More commonly they forage in branches, branchlets and twigs of taller trees, in the crown of saplings, and in bushes. They move rapidly, pausing to pick insects from the bark, to tap the bark a few times, to pry a piece of bark, and to peer and probe at the bases of leaves. Most food is secured at or just below the surface of trees in these manners, and long bursts of tapping and excavating are rare. This agile woodpecker frequently perches crosswise, and it also seeks food by hanging from the tips of leaf clusters, in many cases upside down. It also holds its body far out from the tree, often at a 45-degree angle. I saw most of the individuals (perhaps 18 birds on 52 separate occasions) glean food items at least once, sometimes frequently, by fluttering in front of an otherwise inaccessible leaf or leaf cluster. Normally a foraging bird systematically works its way through the foliage and smaller branches of a tree, then moves to another nearby tree to repeat the performance. Sometimes only a few branches are utilized for foraging, and the birds move very rapidly through the forest from one to another limited site. When foraging on tree trunks, a Gray-cap proceeds upward rapidly, gleaning, swiping with its bill at crevices, tapping almost as it moves, and not tarrying at one site, as does *P. macei*, for instance. Gray-capped Woodpeckers foraged in family groups or in pairs at the time of my visit to India. Members of pairs usually forage in the same or adjacent trees, and often they forage within a meter of one another. Birds observed in Malaya were solitary individuals.

Competition occurs between *P. canicapillus* and *P. macei* in northern India, and almost surely it occurs between *canicapillus* and *moluccensis* (which

in size and coloration seems much more like *canicapillus* than does *macei*) in Malaya. On May 3 at Sukna, West Bengal, I watched a pair of Gray-capped Woodpeckers foraging and feeding a recently fledged young bird in a large tree in which a male *P. macei* also was foraging. During 25 minutes of observation of these four birds in that one tree, the male *P. macei* foraged entirely on the trunk and branches. The Gray-capped Woodpeckers foraged 90 percent of the time on twigs and branchlets and 10 percent of the time on small to moderate-sized branches. In the course of foraging, the *macei* male three times approached one or another *canicapillus* feeding in twigs to within a distance of one meter without a noticeable interaction or disturbance. However, on the four occasions when a Gray-capped Woodpecker moved onto a moderate-sized branch, the male Streak-breasted Woodpecker swiftly moved toward it and supplanted it. This occurred even when the Streak-breast was several branches removed from the Gray-cap. The change in action of *macei* was pronounced as a result of such apparent transgressions, for the foraging bird abruptly speeded up, and altered or reversed its course in hopping toward (but not flying at) the Gray-capped Woodpecker, as well as displaying (Bill Directing, Wing Flicking, see *P. macei*) if the latter tarried too long before fleeing. The Gray-capped Woodpecker did not display, but simply flew to the twigs when approached or in response to displays of *macei*. Also, on May 1, I saw a male *macei* fly to the lower trunk of a tree in which a pair of *canicapillus* were feeding. The Gray-caps were at a Y fork in the trunk, and one bird moved upward into the foliage as the *macei* approached. The other *canicapillus* moved around the trunk of the tree. The *macei* moved rapidly, stopped foraging, and headed directly for the *canicapillus*; within 1 meter of the latter, and within its sight, it spread its wings and lunged forward with bill pointing at the *canicapillus*, which flew away. The active restriction of *canicapillus* to outer foliage, and the attacks by the larger *macei* seem to represent a clear case of competitive exclusion, for which data are forthcoming only rarely.

The Gray-capped Woodpecker was seen infrequently in Malaya, and hence I know nothing of its nesting there (no report exists of its breeding in Malaya). In northern West Bengal this woodpecker was nesting in late April and early May. Young already out of the nest were being

fed in five cases, and in two instances nests were found containing young birds. Nests were in a dead stub at 15 meters above the ground, and at 13 meters up a double-topped, 18-meter-tall dead tree. Young were fed regularly at about 15-minute (10 instances, four to 32 minutes) intervals at both nests. The adults carried food (insects) in the bill, and seemed to bring a number of them at once (large masses with many insect appendages visible in the bill). Adults feeding young out of the nest usually had the young accompanying them (up to three juveniles seen with two adults). Sometimes the young birds simply perched at one site, and the adult made a foraging circle through nearby branches, then back to one or another young bird. In most cases (young birds longer out of the nest?) a juvenile perched quietly after being fed, then moved more or less leisurely after an adult bird, speeding up to meet it when the adult was ready to feed. In one case a young bird was fed on a small branch. The adult then moved rapidly up the branch to the point at which it previously had foraged. Then it gleaned for about 2 meters up the branch, picking up three items, and delivered three pecks at a twig-stub base, extricating an insect therefrom. The juvenile perched quietly for a moment, then hopped in the direction of the adult. At a broken stub along the branch it paused, glanced down at the break, delivered a light exploratory peck, then hesitantly pecked twice more, apparently without securing an insect. By this time the adult had obtained at least four items of prey, and turned toward the juvenile, which promptly moved toward the adult. The bill of the adult was inserted into the youngster's bill three times in quick succession, the bills of the two birds being placed in opposing planes (perpendicular to each other) due to the parent turning its head sideways to insert the bill, and then the adult turned and flew to some twigs in the top of the tree. The juvenile followed the adult, but landed on a branch rather than in the twigs. The young bird appeared very plump, and its movements were awkward. No other adult or young birds were seen at the site. These feeding data were obtained through movie analysis.

Displays of the Gray-capped Woodpecker include Crest Raising, Bill Directing, Tail Spreading, and Swinging. Crest Raising is incipient only, and was detected through movie analysis. This species has no crest, and its nape

is not colored red. Rather, males have tiny red marks usually concealed in the plumage just behind the eye (as in *P. moluccensis* and *P. borealis*). Males feeding young birds raise the nape feathers slightly, so that the red spots are clearly visible as the male turns its head to feed the young (two cases; both young birds were males with much red on the head). This appears to represent an aggressive reaction of the male to close contact with the young birds. I saw no Crest Raising by females, probably because they lack red marks that call attention to the (slight) Crest Raising in males. Bill Directing was evident in birds reacting to proximity of other individuals, as for example a male Bill Directing at a female that moves too fast around a branch and inadvertently comes near the male. I also saw an adult (sex unknown) chase another adult foraging in the same tree; it pursued the latter, landed near it, and, leaning forward, Bill Directed at its antagonist, then slowly swung its body and head two or three times, maintaining the Bill Directing. At the same time it gave a Rattle Call (see below). Its antagonist fled and was chased out of my sight. I also observed Bill Directing by adults at young birds after the adults fed them—on three occasions the youngster followed the adults, apparently too closely, the adults faced about and lowered the head and bill, pointing toward the juvenile bird, which stopped and hung back from that point on. The Swinging and Bill Directing appeared like that evident (Schlegel and Schlegel, 1971, p. 253) in figures of displaying European Lesser Spotted Woodpeckers (*P. minor*), a close relative of *P. canicapillus*. Tail Spreading very like that of New World *Picoides scalaris*, *P. nuttallii*, and *P. pubescens* (Short, 1971b) was also seen at intervals during the few chases that I encountered. I saw a bird spread its tail and Bill Direct simultaneously at another (adult) bird that subsequently supplanted it. In other cases birds engaged in chases appeared to have their tails spread in flight, and as they landed, but thereafter Tail Spreading was reduced or not used to the extent that it is in other species (those just mentioned and *P. macei*). All of these displays are thought to be agonistic in function, but study of their use with respect to one another awaits more data.

Drumming has been reported in the Gray-capped Woodpecker (Ali, 1962; Caldwell and Caldwell, 1931; Smythies, 1953), but I failed to hear drumming that could be ascribed to this

picid either in Malaya or in India. However, Malayan birds may not have been breeding, and Indian birds were fully engaged in care of young at the time I visited those areas, hence drumming might occur at other seasons.

Vocalizations of Gray-capped Woodpeckers include a soft unaccented single or double "pit," or "pi" note (Pit Call) sometimes audible at a distance of 100 meters, a soft Rattle Call variably fast ("ti-i-i-i-i-i or "ptttttttt") or slow ("pi-ti-ti-ti-ti-ti"), infrequently heard beyond 50 meters from a calling bird, and a relatively loud Kweek Call. Stuart Baker (1927, p. 52) also has reported a "curious squeaking noise" produced by a male chasing a female, then uttered by the female when the male ceased to call. I did not hear the latter call.

The Pit Call of *canicapillus* (fig. 15c) is a short, sharp but soft call lasting 0.025 to 0.035 second (five single calls). Its form is that of an inverted, tight U or V emphasized on the peak of the fundamental tone at 2.4 to 2.7 kilocycles, and on the legs and peak (at 4.8 to 5.3 kilocycles) of the initial harmonic tone. These two tones either are codominant or the peak of the fundamental tone is but slightly stronger than the other sound. There is virtually no tailing of sound beyond the note. Double Pit Calls contain a longer, more U-shaped note followed by a shorter, lower pitched, more V-shaped note. The notes of the double Pit Call tend to be shorter (0.02 to 0.03 second) than in single calls. The interval between notes is 0.04 to 0.05 second, and the double note is 0.09 to 0.10 second long in its entirety. In four double Pit Calls the peak of the fundamental tone and the peak of the initial harmonic tone are codominant, and there is a slight but definite tailing of sound in the initial harmonic tone. The shift in pitch is from 2.4 to 2.3 and 2.5 to 2.4 kilocycles in the fundamental tone of the four examples analyzed (initial harmonic tone peaks shift 0.2 kilocycles in every case, from 4.7 to 4.9 kilocycles down to 4.5 to 4.7 kilocycles). These notes are interspersed with Rattle Calls, and serve an agonistic function as well as perhaps a localization function. Calling birds inevitably either were disturbed (e.g., by my presence, by *P. macei* being near), or were engaged in agonistic encounters. The Pit Call is similar to that of sympatric *P. macei*, but is less intense, has a lower pitched fundamental tone, which is, however, usually weaker than the initial harmonic tone, and is sometimes given as

a double note unlike the Pit Call of *P. macei*. Also *P. canicapillus* uttered the Pit Call less often and the Rattle Call more often than did *P. macei* in India.

The Rattle Call (fig. 15d) essentially is a series of pit notes, containing six to more than 17 notes (eight examples) uttered in 0.45 to 1.06 second. The tempo varies from about 16 to 19.4 notes per second, with irregularity because of one or more double notes occurring in half the calls analyzed, and because of the variability in the gaps (from 0.02 to 0.07 second, one terminal note 0.11 second after the penultimate note). Single notes in the calls vary from 0.015 to 0.045 second in duration, with the first note often the longest (in six of eight cases), but otherwise with considerable variation throughout each call. Shorter notes tend to be pitched lower than longer notes. Emphasis is on the fundamental and initial harmonic tones with respective peaks at 2.2 to 2.7, and 4.3 to 5.4 kilocycles. Double notes contain a longer, higher pitched note followed immediately (even running together with no interval) or within 0.01 second by a shorter, lower pitched note. These sporadic, double notes recall the double Pit Call notes. Most of the Rattle Calls were associated with Pit Calls, which usually preceded them. Four of the Rattle Calls also show an association with the Kweek Call; one or two Kweek Calls preceded each of these. Longer Rattle Call notes, and especially the usually very long initial note, are very like short Kweek Call notes.

The Rattle Call is an agonistic vocalization used during encounters, including chases, and associated with Tail Spreading, Bill Directing, and Swinging displays (see above) in these encounters. *Picoides macei* has a similar but slower, lower pitched, and more regular Rattle Call that was not associated with Kweek Calls. The terminal portion of the Rattle Call of *P. pubescens* also is similar, but the fundamental tone usually is dominant.

The Kweek Call (fig. 15h) is a single note to a series of notes, rendered "kweek-kweek-kweek," varying in duration but pitched like Pit or Rattle notes. Kweek notes are irregular in form, but are longer than notes of other calls (duration 0.055 to 0.12 second for 12 notes). Some notes are inverted, U-shaped, but most are asymmetrical, having a step in the rising or in the falling portion, showing sub-peaks, or a flat top. A characteristic of these notes is the strong

emphasis on the fundamental tone (peak at 2.2 to 2.8 kilocycles), which is dominant in nine notes and codominant with the initial harmonic tone (peak 4.2 to 4.7 kilocycles) in three other notes. Six Kweek Calls contained one ($N=2$), two ($N=3$), and four ($N=1$) notes. All but the longest preceded Rattle Calls, and one containing two slightly skewed notes showed a "conversion" to a Rattle Call note by shortening (0.07 to 0.055 to 0.03 second for consecutive Kweek and Rattle notes), by becoming symmetrical, and by a slight drop in pitch (2.4 to 2.3 kilocycles, fundamental tone). This shift, and the association of Kweek and Rattle calls suggest their basic similarity in function, as well as in form. Kweek notes in series are 0.08 to 0.16 second apart, and the four-noted call, lasting 0.68 second, was uttered at a rate of 5.8 notes per second. The form of these notes, and their rate of delivery render the Kweek Call of *canicapillus* very like the Kweek or Queek calls of North American species of *Picoides*, especially the type B call of *P. nuttallii*, *P. pubescens*, and *P. villosus* (Short, 1971b). Most Kweek Calls of the last three species are higher pitched, but some calls of *pubescens* fall within the range of pitch of that call in *canicapillus*.

I have considered the Kweek Call of North American species of *Picoides* to be an agonistic call of greater intensity than the Rattle Call (Short, 1971b, p. 88). The Kweek Call of *canicapillus* presumably functions similarly; Kweek-Rattle combined calls were associated with interactions, including especially chases among Gray-capped Woodpeckers. Further investigations are necessary to clarify the function of these calls and their interrelationship.

STREAK-BREASTED WOODPECKER

Picoides macei

From northeastern India to Vietnam, Texas, and the Andaman Islands, and farther from Sumatra to Java and Bali, the Streak-breasted Woodpecker occurs in open woodlands and forest edges. It occurs in open lowlands and in hills and mountain slopes. I studied this species at Sukna, West Bengal, at the base of the Himalayas in late April and early May.

Foraging Streak-breasted Woodpeckers favor tree trunks and branches, but they also forage in the foliage on small branches and larger twigs. I saw not the slightest indication of terrestrial

foraging, or even of very low foraging in trees. Foraging modes include gleaning, tapping, prying and probing, and excavating. Their tapping is frequent and audible for some distance. Excavating is infrequent, but a light burst of taps, often heard, approaches excavating in function. In branchlets this woodpecker is agile, although less so than is sympatric *P. canicapillus*. I saw one male drop from a nearly vertical branch, flip over in a somersault, grab at some item of prey on a branchlet below it, then land lower down on the branch from which it took off. Apparently this woodpecker feeds on ants and other insects but details of its diet are not known. Interactions and interspecific competition with *P. canicapillus* are discussed above, under the latter species.

Active chasing, calling, drumming and other actions of these birds indicated that early May is a period of pair formation and the beginning of the nesting season, which is reported as from April to May in India (Ali and Ripley, 1970). No nests were found, and I did not observe copulation.

Bill Directing, Head Turning, Swinging, Tail Spreading, Wing Flicking, Wing Spreading, Crest Raising, and a Flutter Aerial display were observed in *P. macei*. Details of some of these displays were taken by analyzing movies (figs. 16–18) as well as observations. Some displays were used interspecifically (see *P. canicapillus*). Most intraspecific encounters were unisexual, mainly between males. However I observed female-female chases, and females actively were engaged in "inciting" males participating in encounters. At least two of the females in flying by two males did so in a Flutter Aerial Display very like that described in various North American species of *Picoides* (Short, 1971b, pp. 78–79).

Two males chased each other back and forth over trees on May 1, Rattling frequently and uttering at least one Kweek Call. A female was perched nearby. On several chases by the males in which they passed over the quiescent female, she suddenly tapped lightly with her bill, either in signal-tapping (no other aspects of display were apparent) or as a displacement activity. The males at one point dropped below the canopy and perched briefly in a small tree. One male was the aggressor; with crest slightly erect, bill forward toward the antagonist, it approached the other—both maintained their tails moderately spread (barred outer rectrices

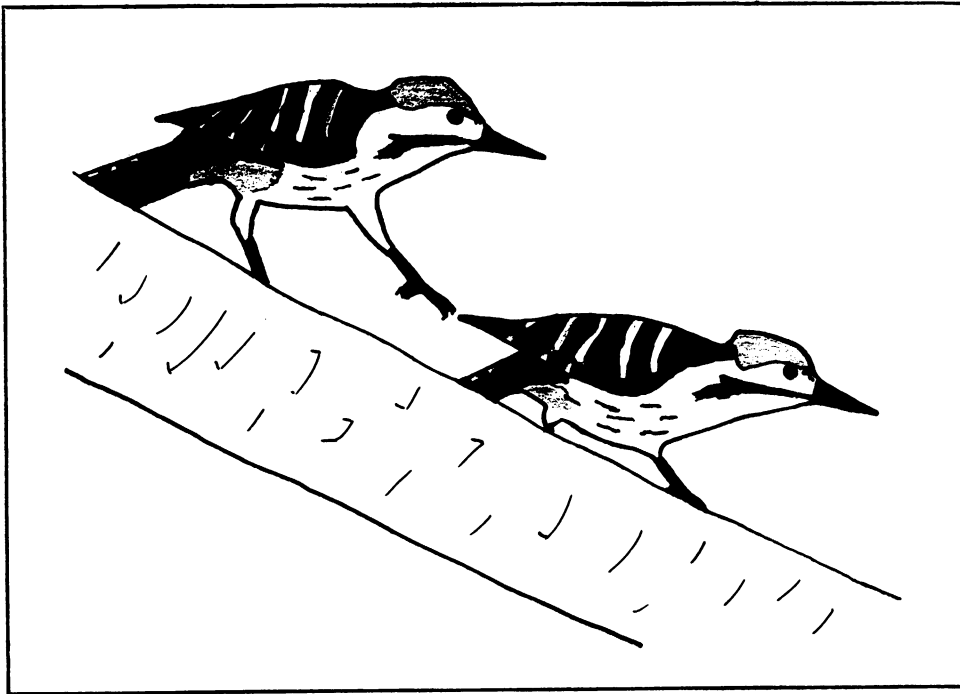


FIG. 16. Encounter of Streak-breasted Woodpecker (*Picoides macei*). Aggressive, dominant male strides to right to supplant another male. Note bill directed at opponent, crest slightly raised, tail spread little if at all. Bird steps rather than hops (it moved toward opponent in a hop, three running steps, including one shown here, followed by another hop). The bird is 18 cm. long. Drawing from 2 consecutive frames (speed 24 ft. per sec.) of 16 mm. movie, taken at Sukna, West Bengal, India.

conspicuous)—and when the bird did not retreat before it, the aggressor stopped, then swung its body from side to side, bill still directed toward the other bird. I could not detect a vocalization at this time. The Swinging was repeated three times, then the intimidated male tapped lightly and rapidly twice in succession. Its crest was lowered. The more aggressive bird flicked its wings several times, uttered a Rattle Call and moved forward, at which point the other bird flew and another chase occurred.

Some chases were accompanied by more vocalizing, with constant Pit Calls in loose series, interspersed with short Rattle Calls, and occasionally (in flight) a Kweek Call. Intense encounters seemed to be typified by less (loud) calling, little or no Crest Raising, more Tail Spreading (both birds), wider Swinging (head and bill farther to side), Bill Directing with the head held high, much emphasis on Head Turn-

ing, and little Wing Flicking. Less intense encounters in which one bird seemed clearly to be dominant involved more loud vocalizations, and, on the part of the aggressor, stronger Wing Flicking, Bill Directing forward (at the antagonist), a less spread tail, moderate Crest Raising, and forward-directed Swinging. An intense encounter is depicted in figure 17. The male at the right is slightly more aggressive. It faces its antagonists but holds its bill high. Its wings are very slightly spread and its tail is moderately spread, as it Swings narrowly. The bird at the left keeps its Head Turned (body also directed to one side), its tail is spread (less than in the other bird), and it Swings more broadly from side to side. The bird at the right eventually supplanted the other bird, moving around the limb largely out of my view.

In another encounter two males perched opposite each other on a diagonal limb 15 centi-

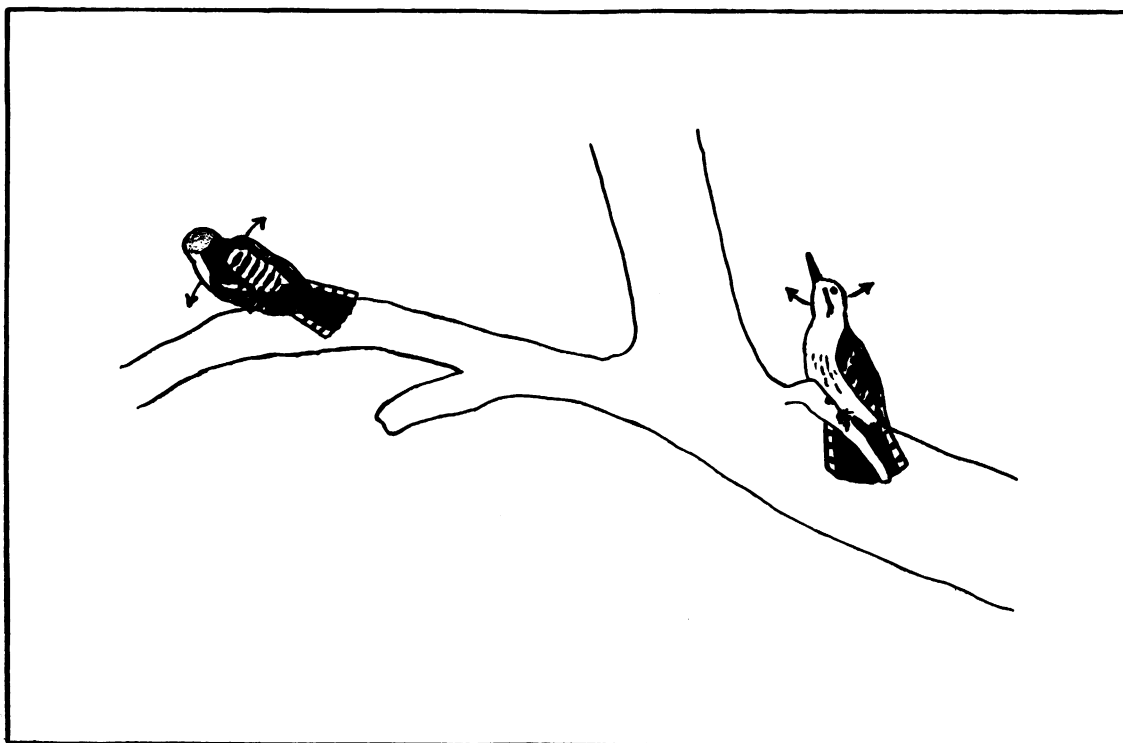


FIG. 17. Encounter of male Streak-breasted Woodpeckers (*Picoides macei*). Male at right is Tail Spreading, wings slightly spread, bill upward, and moderate but slow Head Swinging as indicated by arrows. Male at left is Head Swinging moderately, directing head and bill away from antagonist; wings and tail are spread slightly. Note conspicuous back bars, spread tail, malar streak. Birds are about 18 cm. long. Traced from photographic slides taken May 1, 1972, at Sukna, West Bengal, India.

meters in diameter, such that male 1 was directly above male 2. Male 2, the aggressor, slowly moved around the limb away from me (out of view), and stopped momentarily with its head barely in view behind and to the right of male 1, which spread its tail broadly and turned its head away from male 2. At this point an apparent female flew by, about 3 meters above the two males. Male 2 hopped into view, its crest moderately raised, bill forward but slightly to one side. Male 1 turned its head away, then hopped laterally as male 2 supplanted it, half Bill Directing and with Wing Flicking. At this point the males had changed places from their starting positions. A moment later, male 2, its tail only slightly spread, turned its head fully to the side, and sidled toward male 1 which had its crest moderately raised—male 2 then spread its tail and wings, Wing Spreading such that the wing away

from its opponent was outstretched, that toward the opponent was held in a "Wing Flick" position, and turned its head, cocking it farther from its antagonist as it took another sidling step toward the latter (shown in fig. 18). Male 1 lowered its crest slightly, and turned its head away. The pattern of barring on the half-closed (left) to spread (right) wings formed almost a concentric series of black and white lines (barring on wings), setting off the barred edges of the spread tail and laterally twisted head (almost as in the Wing Spreading *P. nuttallii* shown in fig. 20G, Short, 1971b) in a most conspicuous manner. Male 1 lowered its crest at this point. Male 2 stepped closer, spreading both wings and bringing them down on, with the tail now directed laterally toward its opponent (both birds now literally side by side). Male 1 dropped downward, back first, from its perch, and

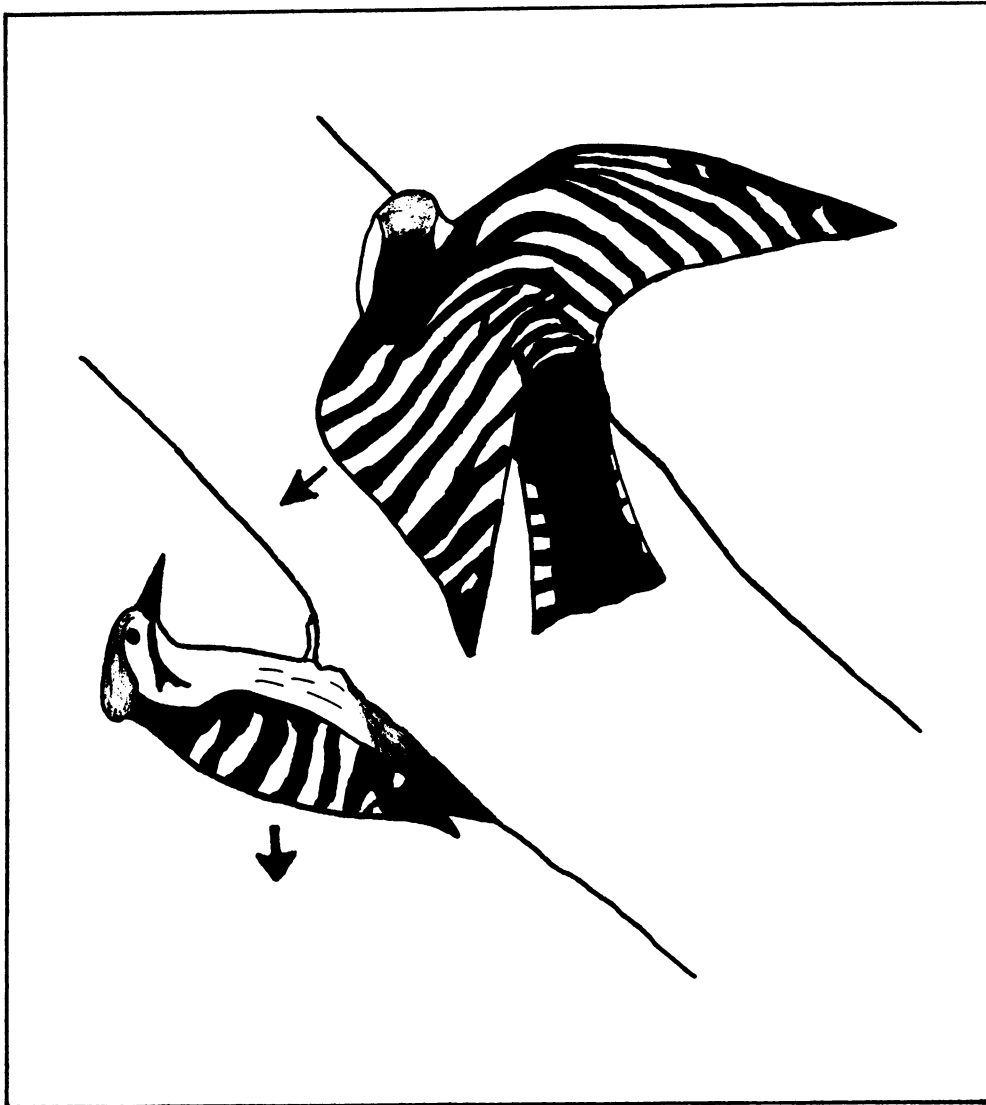


FIG. 18. Supplanting attack in male Streak-breasted Woodpeckers (*Picoides macei*). Male, at top (male 2, dominant, see text) is sidling toward lower male (male 1 in text), spreading right wing and holding left wing in Wing Flicking position, Tail Spreading, and simultaneously Head Turning away from male 1. Lower male, with bill held high and crest raised slightly, responds to sidling of male 2 by lowering its crest (in the next movie frame, see below), then by dropping downward in a somersault (3 frames later), Wing Spreading in the process, as male 2 supplants it. Birds are 18 cm. long. Drawn from a frame of 16 mm. movie film exposed at 24 frames per second at Sukna, West Bengal, India on May 1, 1972.

fluttered, perhaps displaying (Wing Spreading) fully upside down into the beating wings of male 2, which now closed its wings, having supplanted male 1 (which somersaulted and

assumed a perch farther down the branch). Shortly thereafter both flew off in a chase.

In another incident, a dominant male thrust forward its head and bill, with crest partly erect,

then (fig. 16) lowered its body and rapidly moved (actually running, that is, it stepped or walked rather than hopped) at its antagonist, flicking its wings lightly as it did so, and uttering rapid Pit Calls. The other male ducked behind the limb, and thus was supplanted. The fleeing male then appeared around the limb, hastily moving upward to where its antagonist had been. Its crest was not erect, and its tail was spread; of course its back, including the back of the head were toward the aggressor. As the latter appeared around the limb its head was still forward (Bill Directing) and its crest was raised; both birds stopped, and the male that had fled Head Turned. At this point both birds paused about 40 centimeters apart. Suddenly a presumed female darted by, about 2 meters above the branch, diving downward in a Flutter Aerial Display exactly between the two males (the flight of the female resembled closely that of *P. nuttallii* in fig. 21D, Short, 1971b). As this bird passed over, the male that had fled remained still, whereas the aggressor turned its head, following the path of the female with its gaze. Four movie frames after (i.e., one-sixth of a second later), the aggressive male lowered its head and hopped upward once—the other male promptly flew off and was pursued by its antagonist.

The various displays, and their employment closely resembled displays of *P. scalaris* and *P. nuttallii* (Short, 1971b). Some differences were noted, such as the greater use of Tail Spreading by aggressive Streak-breasted Woodpeckers, and utilization of the sidling, Wing Spreading attack that I had not seen in the North American species, but generally the similarity of these displays is remarkable.

I heard no drumming by Streak-breasted Woodpeckers, paralleling the case of the Gray-capped Woodpecker. Vocalizations of *P. macei* include a Pit Call given singly or in a very loose, irregular series, a Rattle Call with notes essentially like Pit Call notes, and a Kweek Call. The Pit Call (fig. 15c) notes are 0.03 to 0.04 second in duration, and emphasize a peak of the fundamental tone at 2.2 to 2.5 kilocycles and the legs and peak of a harmonic tone peaking at 4.4 to 4.9 kilocycles. A second overtone peak sometimes is evident at 6.5 to 6.8 kilocycles. This call is sharper than that of sympatric *P. canicapillus*, but less sharp than the Peek Call of *P. scalaris* or the Kix Call of *P. major* (personal observ.). Its

pitch is lower than in the Pit Call of the Gray-capped Woodpecker, and it shows a stronger tailing effect (at peak of the dominant or co-dominant initial harmonic tone), double Pit Calls are infrequent compared with *canicapillus*, and the Pit Call is employed more frequently than in that species.

Rattle Calls (fig. 15f) contain pitlike notes regularly uttered at 12.5 to 13.5 notes per second (four calls of 10 to 15 notes uttered in 0.80 to 1.18 second), thus slower than such calls of *canicapillus*. The pitch of the notes is like that of Pit Call notes, and the fundamental and an harmonic tone are emphasized as in those notes, except that the harmonic tone (peak 4.3 to 5.0 kilocycles) is dominant in all notes. Three double notes are contained in the four Rattle Calls analyzed. These notes are like those of Rattle Calls of *canicapillus* except that the second note of each pair is pitched at the same or a higher pitch than the first, not lower as in *canicapillus*. Initial and terminal notes of Rattle Calls seem to be the longest, and the highest (or among the highest) pitched notes of a call, and the terminal note is separated from the penultimate note by the greatest internote gap of a call within two of three analyzable calls. I heard no Kweek notes associated directly with Rattle Calls, as occurred in half the *canicapillus* calls. Rattle Calls of *macei* are most like those of *canicapillus* among species of *Picoides* that I have studied.

Unfortunately no Kweek Calls of the Streak-breasted Woodpecker were recorded, and fewer were heard than among Gray-capped Woodpeckers. Also there was some association of (series) Kweek Calls with Rattle Calls, but not the intimate relation of separate Kweek notes with Rattle Calls found in *canicapillus*. All Kweek Calls of *P. macei* consisted of series of notes, louder and seemingly longer than series Kweek Calls of *canicapillus*. The Kweek Call is thought to be related to the Rattle and Pit Calls in an agonistic, vocal hierarchy of decreasing intensity. Rattle Calls were uttered by foraging birds disturbed greatly by my following them from site to site, as well as by individuals engaged in conflicts. Chasing birds gave Pit Calls, only switching to Rattle Calls when engaged in a display bout with another individual, and during repeated chases (in which the pursuing individual may not have been the same for every chase). Kweek Calls occurred in extended agonistic

encounters, especially when a female was present in the vicinity of a male-male encounter. Only additional data will permit the determination of whether or not the Kweek notes bear the same relation to Pit and Rattle notes as in the case of *canicapillus*.

CRIMSON-BREASTED WOODPECKER

Picoides cathpharius

This attractive pied Woodpecker inhabits lower and middle mountain slopes from Nepal to southwestern China, and south to Burma, Thailand, and Laos. Generally it occurs at lower elevations (4000 to 8000 feet) than does *P. darjellensis*, but it has been reported at elevations up to 13,000 feet (Sikkim; Ali, 1962). Near the Nepalese border 7 miles southwest of Darjeeling, where Darjeeling Woodpeckers were common, I observed a female Crimson-breasted Woodpecker foraging in trees in the same manner as the Darjeeling Woodpecker. The female worked in moderate-sized branches 20 meters up an oak tree. It moved about, tapping frequently, and it excavated twice in the 15 minutes in which it was observed. It then flew downslope calling pit, which I recorded. A little later on that day (May 5) I again encountered a female in the same area, and near where two Darjeeling Woodpeckers were feeding. I could not follow the Crimson-breasted Woodpecker, and it disappeared after I recorded two of its Pit Calls. On the following day I again saw a female, apparently the same individual in the same place. I elicited more Pit Calls from it before it again flew downslope. A gradual pursuit, made difficult by the incredibly steep slope, eventually turned up a woodpecker, apparently the same bird farther downslope, but I could not see it well in the foggy, moss-draped trees. It uttered a few pit notes, which I missed recording, and a Short Rattle Call, which I recorded, then it disappeared across a ravine and was lost to view.

The Pit Calls of *P. cathpharius* (fig. 15c) are like those of *P. macei*, which does not occur in the montane forest at 7000 feet where I saw *cathpharius*, but are shorter, more inverted V- than inverted U-shaped, and they lack the slight tailing effect evident in the Pit Calls of *macei*. Three Pit Calls of *cathpharius* each are 0.025 second in duration. Emphasized are the peak of the fundamental tone at 2.1 to 2.3 kilocycles, dominant

in two calls, and the legs and peak (at 4.2 to 4.4 kilocycles, lower pitched than all but one call of *macei* analyzed) of the initial harmonic tone, codominant in the call illustrated (fig. 15c). All calls of *macei* were 0.03 second or longer in duration. These Pit Calls of *cathpharius* are very different from the sharper Peek Call of *P. darjellensis* and the similar Kix-Peek call complex of the *P. major*-*P. syriacus* group (personal observ.). As usual, the call notes were uttered in a situation marked by a disturbance, namely my presence. The Pit Call is presumably a low intensity agonistic call.

The single Rattle Call that I heard and recorded (fig. 15e) was a burst of four notes, rapidly uttered in 0.115 second, each note being 0.015 second in duration. The form of the notes is like a tight, inverted V, that is like the Pit Call note, but shorter, with the legs (first harmonic tone) approximating to form a vertical column. The converged legs and peak of the initial harmonic tone are codominant with the peak of the fundamental tone. The four notes drop consecutively in pitch from 2.1 to 1.8 kilocycles (fundamental tone; from 4.1 to 3.7 kilocycles in the peak of the initial harmonic tone). The intense sound is between 1.8 and 4.1 kilocycles. At a rate of 34 notes per second this is one of the most rapid of picid vocalizations, resembling in tempo only the begging "Rattle" Calls of juveniles, e.g., of *Picoides major* (unpublished sonagrams). Short Rattle Calls tend to be faster than usual Rattle Calls (as in *P. scalaris*, Short, 1971b), and they may differ functionally as well. From the shortness of the Pit Call and Short Rattle Call notes, and the tempo of the Short Rattle Call, I estimate that the Rattle Call of *P. cathpharius* will prove to have a rate of delivery of 20 to 25 notes per second.

DARJEELING WOODPECKER

Picoides darjellensis

The Darjeeling Woodpecker is an upper montane woodland bird ranging from Nepal to southern China and Burma. It occurs above 4000 feet in Burma, and up to 13,000 feet in Sikkim, where it usually is found between 6000 and 10,000 feet (Ali, 1962). About Darjeeling I found it locally common above 6800 feet in oak and rhododendron forests. With its yellow neck, white wing patches, and red belly it is one of the most attractive of the pied woodpeckers.

Foraging occurs in trees at varying heights, chiefly on the trunk and branches, but also in small branchlets. Dead trees or stubs of any size are visited at regular intervals (once or twice a day in six cases), even if the tree stands outside the forest border. Fallen logs covered with moss also are visited. Birds prefer moss-draped limbs on which they progress slowly, picking and tapping regularly compared with rapid movement between tapping sites on smooth trunks and branches. The foraging modes of *darjellensis* are diverse, with some gleaning, probing, tapping, and excavating all occurring regularly. In mossy portions of trees Darjeeling Woodpeckers noiselessly poke and probe, shaking aside debris and moss, then vigorously tapping four or five times at the cleared site. In dead stubs movement is slower and the audible tapping is frequent, although excavation occurs only sporadically (e.g., once in 20 minutes, twice in 45 minutes on two occasions). The birds appear to feed on varied surface and subsurface insects. Individuals feed alone, or loosely in pairs in separate trees but maintain visual and auditory contact at intervals. According to Ali (1962), this species participates in mixed foraging flocks, but I did not see them so engaged.

No nesting activity was noted in early May near Darjeeling, although paired birds were observed on a number of occasions and drumming was heard frequently. Young birds are reported in May in Burma (Smythies, 1953), and nests containing two to four eggs in April and May were mentioned by Ali (1962) for Sikkim birds.

I saw no displays other than Crest Raising, which was evident in a drumming male, and in two Peek-calling males, each foraging near a female. In these instances Crest Raising was slight to moderate.

Drumming (fig. 15b) by both males and females was common in early May. Unfortunately only three drumming bursts were recorded in analyzable form, but those heard were regular, fairly loud bursts each lasting roughly one second. Those analyzed were 1.00 to 1.18 second in duration and contained 21 to 26 beats given at rates of 21 to 23 beats per second, which is about that of *P. major* (personal observ.). In fact the drumming of *darjellensis* is very like that of *major*, although most drums of the latter that I have heard were less than one second in duration. Drumming presumably functions in

territorial proclamation, and seemingly as a localization sound for members of a pair.

Vocalizations of the Darjeeling Woodpecker include a Peek Call and a Rattle Call, both of which I tape-recorded, and a wicka-like Tewk Call (see Short, 1971b, pp. 88–89) heard in different forms from a pair, but which I was unable to record on tape. The Peek Call (fig. 15c) is a loud, sharp note on sonagrams showing a diffuse, vertical column of sound from 1.5 to as high as 7.0 kilocycles. Basically an inverted, U-shaped note compressed such that rising and falling legs approach one another, peaks are more or less evident at about 1.7, 3.5, 5.0, and 6.7 kilocycles. The initial harmonic tone (peak at 3.1 to 3.7 kilocycles) is dominant, and sound is most intense between the fundamental peak (1.4 to 1.8 kilocycles) and the peak of the dominant tone; it is this level of pitch at which there is a tailing effect beyond the note. Without this tail notes are 0.025 to 0.03 second in duration. The Peek Call of *darjellensis* closely resembles the Peek Call of *P. syriacus* (fig. 15c) and *P. himalayensis* (comparison with the last using sonagrams from tapes made by G. Thielcke in Nepal, made available to me by D. Blume), and the Kix Call of *P. major*. The Peek Call seems to indicate low intensity aggression, as when a Darjeeling Woodpecker was mildly disturbed by my presence, or by its mate flying overhead or assuming a perch nearby.

The Rattle Call of the Darjeeling Woodpecker was heard only five times in four days, and I was able to record only two distant calls on tape. Sonagrams of these calls nevertheless indicate clearly that the Rattle Call of this species is not simply a series of call (Peek) notes as in species such as *P. canicapillus*, but that the two calls differ substantially. The two calls lasted over one second (1.06, 1.18 seconds) and contained 13 and 15 notes respectively. The tempo of between 12.0 and 12.7 notes per second is faster than the Rattle-like calls of *P. major* (six to nine notes per second) and *P. syriacus* (eight to 10 notes per second, unpublished sonagrams of Austrian birds' vocalizations). The notes are inverted, U-shaped, with the initial harmonic tone emphasized (legs from 3.5 up to peak at 4.4 or 4.5 kilocycles); the peak of the fundamental tone at 2.2 kilocycles is somewhat weaker. The pitch of these notes, which are about 0.025 second in duration, about matches that of notes in some calls of *P. syriacus*

(personal observ.). The Rattle Call marked interactions between male and female; in one instance it was uttered by a male flying to join a female after feeding apart from it. I could not see the calling bird in the other cases, but two birds (pair) were seen in the area whenever I heard a Rattle Call.

A Wicka-like call, written in my notes as first a "tchew-tchew-tchew-tchew," followed by a lower "ch-wee, ch-wee, ch-wee" series, was uttered by one or the other of a pair of birds when a male flew to a limb on which a female was foraging. Unfortunately, he landed on the opposite side of a branch one-half meter from the female, and I could not see if he displayed. The female perched in an upright stance, and turned its head away from the male, but the movement did not appear to be a ritualized Head Turning Display. The female then moved away from the male, toward the end of the branch, and soon thereafter it flew to another tree. The call was extremely like the Tewk Call of some North American species of *Picoides* (see Short, 1971b, p. 89). In *P. scalaris* and *P. nuttallii* the Tewk Call apparently serves as an agonistic vocalization, perhaps with an appeasement function in interactions between mated birds. A similar function seems likely for this equivalent call in *P. darjellensis*.

RUFIOUS WOODPECKER

Celeus (Micropternus) brachyurus

This common woodpecker ranges widely through the lowlands and lower mountain slopes from the Himalayan foothills and elsewhere in India to southern China, Hainan, Vietnam, and Sundaland. Its habitat requirements apparently are very broad, for it is common in primary forest, second growth, palm groves, reed beds, bamboo gardens, and even mangroves. Edges and scattered trees in open country are utilized, as well as dense woodland. Rufous Woodpeckers tend to forage in darker, more dense portions of trees, and among vines and foliage, although they frequently are seen in the open. Their coloration, and tendency to perch quietly when disturbed render them inconspicuous, but they are very vocal, and drum frequently when intruders are not nearby. Calls and drums of this woodpecker are among the commonest picid sounds in lowland forests.

The diversity of habitats in which the Rufous

Woodpecker is found is matched by the diversity of its foraging sites. It has been noted foraging on the ground on dung hills, on termite mounds, and on ant hills in India (see, e.g., Henry, 1955), although I never observed the bird on the ground. Foraging occurs on fallen, rotted logs, in vines at all heights from the ground, along trunks of saplings and large trees, on bamboo stems, and in branches and branchlets of trees of all heights. They only infrequently forage in leaf clusters far out at the tips of branchlets, seeming to prefer larger branches. A sporadic tap or two is all the sound I have heard from foraging Rufous Woodpeckers, although they excavate nesting and roosting cavities, and presumably they sometimes excavate to obtain food. However, they chiefly glean and to a lesser extent probe as they forage. Most of their foraging time is spent moving constantly along tree trunk and branches, but frequently they perch quietly for considerable periods at food sources such as ant nests. I saw birds forage for up to 15 minutes with almost no movement at the base of a cluster of coconuts, and on another occasion in cracks at the end of a tree stub that had broken off. In both cases the woodpecker was probing extensively. In bamboos, Rufous Woodpeckers concentrate their attention at the nodes along the stem, moving rapidly between nodes. In coconut groves at Rantau Panjang, Malaya, I saw several Rufous Woodpeckers probing into holes in coconuts, but I could not determine whether they had excavated the holes. They also probe into the cracks at the rough palm frond scars on coconut palms. In tall forest trees they move rapidly up the trunk and along branches, gleaning and occasionally pausing to probe at rough places in the bark. When feeding in the branchlets, as they do occasionally, they hop about, perching crosswise, gleaning as they move, much in the manner of *Meiglyptes tukki*. Various foods have been reported in the diet of this woodpecker. Basically it feeds on ants, as mentioned by all authors noting its food, but it also has been observed feeding on banyan and other fig fruits, on the nectar of flowers of *Bombax*, *Erythrina*, and other trees, and on sap sucked from tissues at the bases of banana leaf fronds (Ali, 1953).

I did not find active nests of this woodpecker, which commonly nests in cavities excavated in tree termite nests, and arboreal nests of ants (*Crematogaster* sp.) just as do other species of



FIG. 19. Presumed old nest of Rufous Woodpecker (*Celeus brachyurus*), Kuala Lompat, Pahang, Malaya. The hole was excavated in tree-ant nest in center of photograph. A male perched at entrance and drummed near it on March 12.

Celeus in the New World (Short, 1970), and also species of neotropical *Piculus* (Short, 1970) and African *Campethera* (Chapin, 1939). I saw several unused nests of this type, which I attributed to this species. One of these, in a *Crematogaster* nest 12 meters up in a (fig. 19) forest tree, had a male *Celeus brachyurus* perched beside it on March 12; this bird failed to enter the cavity, but drummed once nearby, then disappeared. The Rufous Woodpecker also nests in dead stubs of various live or dead trees (Caldwell and Caldwell, 1931, p. 210).

Very few interactions were observed, although calls attracted my attention to numerous, rapidly completed interactions. Wicka Calls (see below) marked encounters, almost entirely between presumably paired individuals. On one occasion a Long Call precipitated an encounter between two pairs, the females of which remained apart

while the males gave Wicka Calls and engaged in Head-Swinging Displays at close quarters. The males flew off, one chasing the other, and the females followed them. Most heterosexual encounters involved slight Head Swinging Displays and weak Wicka Calls, set apart sharply by prolonged periods of immobility. Long Calling birds were answered by distant birds, usually of other pairs (the mate was frequently seen near the calling bird, almost always a male). A male drumming frequently was answered by distant drumming—I noted no long drumming bouts between male and female of a pair (see, e.g., *Meiglyptes tukki*). In one heterosexual encounter a male drummed, a female responded by flying toward him and landing with tail spread, swinging its body, calling “wi-chee- -”; one then gave a “wick-wick-wick- - -” call very like the Long Call of

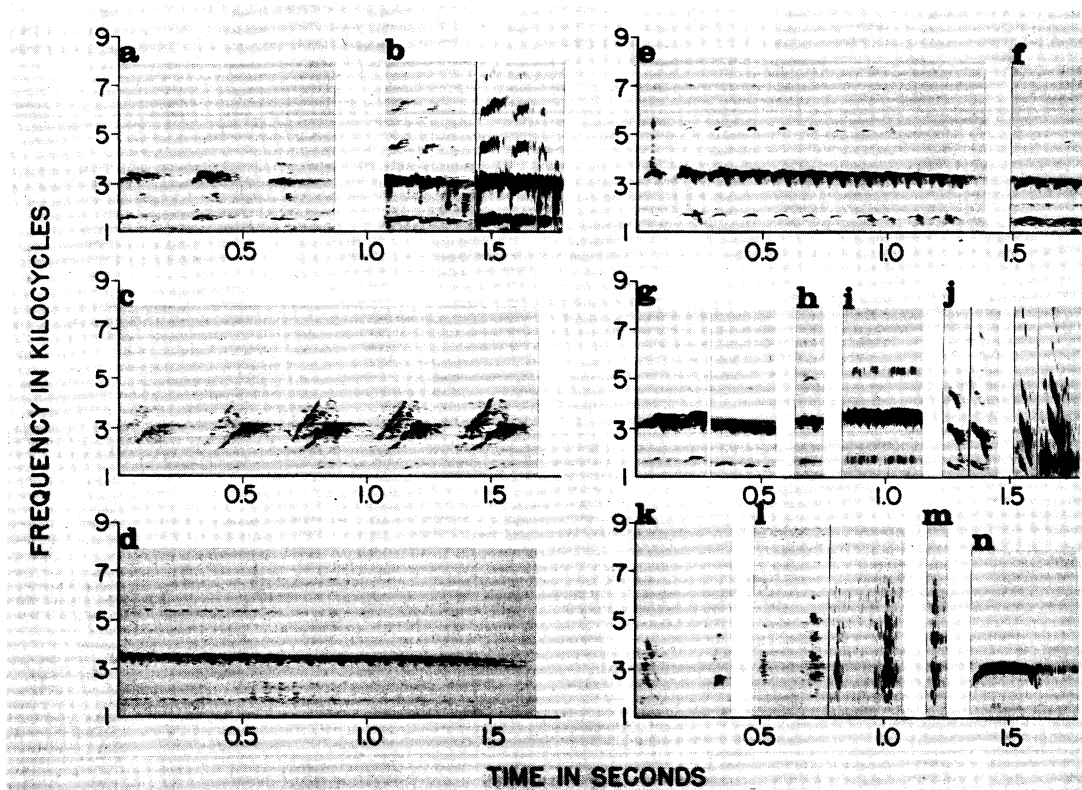


FIG. 21. Sound spectrograms of *Celeus brachyurus* and three species of *Picus*. a. Keek Call of *Celeus brachyurus*, Malaya. b. Short Long Call of *C. brachyurus*, 4 notes, followed by same call, WB, Malaya. c. Kweek Call of *C. brachyurus*, Malaya. d. Complete Long Call of *C. brachyurus*, India. e. Complete Long Call of *C. brachyurus*, Malaya. f. Third and fourth note of atypical, 10-note Long Call of *C. brachyurus*, Malaya (note loud fundamental tone). g. Notes 2 and 3, then 7 to 9 of a 10-note Long Call of *C. brachyurus*, India. h. Double-peaked initial note of 5-note Long Call of *C. brachyurus*, India. i. First two notes of Long Call of *C. brachyurus*, shown in d, here WB. j. Wicka Call "tchew" notes of *C. brachyurus*, Malaya, a shorter and a longer note, followed by different shorter and longer notes, WB. k. Wicka Call of *C. brachyurus*, Malaya, complete, 2-parted ("wick-ta") note from long series of such notes. l. Wicka Call type A note, then type B note, followed by same notes, WB, of immature *Picus vittatus*, Malaya. m. Wicka Call note of *P. canus*, Austria, resembling type B note of Wicka Call of *P. vittatus*. n. Peew Call of *Picus puniceus*, Malaya, WB. See text. All sonagrams are narrow band unless indicated wide band by WB.

Among the vocalizations of *Celeus brachyurus* is the Keek Call, which is given in short series of three notes spaced generally 0.30 to 0.32 second apart, except that the third note may be somewhat delayed (fig. 21a). The notes are inverted U-shaped, with almost all intense sound at the peak (about 3.2 kilocycles) of the initial harmonic tone. There is little variability from call to call. The fundamental tone, which is very weak, peaks at 1.6 kilocycles or, in the case of the terminal note, 1.4 kilocycles. Each inverted

U-shaped note is 0.08 to 0.10 second in duration (terminal note 0.06 to 0.07 second), and has a 0.10 to 0.15 second "tail" or plateau extending beyond the main U-shaped element at its first harmonic peak. About 0.30 second intervals separate the notes. Each peak is somewhat irregular, with a tendency to have a small sub-peak. The U-shaped element appears asymmetrical on the sonagrams because of the "tail," and because its dropping terminal portion receives more emphasis than does the initial rising

portion. This call generally resembles equivalent Keek Calls of *Picus miniaceus*, *Picus mentalis*, and *Picus flavinucha* (which see), but in series the notes are more closely spaced and they show only a trace of downward tapering terminally. As I barely glimpsed the Rufous Woodpeckers that called, I have no suggestion concerning the function of this call, although it was not associated with encounters, but was uttered by lone birds.

A different series call, also infrequently heard, is the Kweek Call (fig. 21c), composed of four or five rising notes emphasized on the initial harmonic tone and to a lesser extent on the next harmonic tone. The notes last 0.2 to 0.25 second, yielding a call of about 1.5 or 1.6 seconds in duration delivered at an average rate of three notes per second. The rise of the loud initial harmonic tone is from 2.0 to 2.8 kilocycles, achieved in two steps, followed by a sharp rise to the peak. A peak is lacking on the fourth note of one call ("kwee" rather than "kweek"); the note rises, then plateaus at 2.7 kilocycles. Following a slight drop after the normal peak of the notes is a plateau extending variably beyond it. Most of the intensity of the notes is encompassed between 2 and 4 kilocycles, and the only intense sound not part of the initial harmonic tone is in the first (rising) part of the next harmonic tone. Kweek Calls resemble notes of the Keek Call in the suggestion of a U-shape of the notes, the plateau effect, and the intense first harmonic at a little over 3 kilocycles. They also bear very close resemblance to some Wicka Call notes, particularly rising "wick" elements of the Wicka Call of *Colaptes auratus* (personal observ.). This call was emitted by individuals apparently in conflict (all three instances), and it may be an aggressive vocal display of greater intensity than the Keek Call.

Wicka Calls (fig. 21j, k) very reminiscent of those of *Colaptes* (Short, 1972) were heard frequently, and mark agonistic or agonistic-sexual encounters. Most calls were very weak, and difficult to hear, let alone to record on tape. The Wicka Call in its various forms is rendered thus in my field notes: "whi-chi, wi-che, wi-cha- -"; "wi-chee, wi-chee, - -"; and "ch-ch-ch- -" (low). There are two basic component notes either uttered alternately in the same call, or in series of only one type of note. The "ti," "wi," or "ch" note is a short (0.015 to 0.02 second duration), vertical, inverted V-shaped

element. The inverted V is tight, that is, the peak is sharp and the bases are close together (fig. 22a). Most sound is at 1.5 to 4 kilocycles, involving the fundamental tone (peak at 1.5 to 2.5 kilocycles) and the initial harmonic tone. The dropping portion is very intense, especially between 1.5 and 2.0 kilocycles. When rendered in series lacking the chew note (see below), the wi notes have the form just described. However, when alternating with chew notes in the same call, they are often longer (duration 0.03 to 0.04 second), forming a wider inverted V with a peak at 2.0 kilocycles (fundamental tone) most intense, the first harmonic tone (peaking at 3.5 to 4.0 kilocycles) weaker, and separated from chew elements by 0.30 to 0.35 or even 0.40 second.

The "chew" (also "cha" to "t-ch") element of the Wicka Call is a dropping, usually wavering note 0.04 to 0.08 second in duration, in which the initial harmonic (dropping from 3.5 or 3.0 to 2.5 or even 1.5 kilocycles) tone is emphasized, the next harmonic tone is moderately strong, and the higher harmonic tone and fundamental tone are weaker (fig. 21j). Some notes, especially shorter ones, drop regularly and evenly from the initial peak to the terminal low point. Others, especially longer notes, initially undergo a rapid drop, followed by a slowdown (forming a step), and then a rapid drop. In these longer notes, the step often receives strong emphasis. In a few stepped notes the initial drop is vertical to the almost horizontal step at 2.5 to 2.8 kilocycles (initial harmonic tone), and then a gradual drop ensues. When alone in series these chew notes are 0.3 to 0.5 second apart. Within mixed calls (having wi notes as well) the chew elements are typical or tend to be somewhat longer, and alternate with wi notes, with a duration of 0.30 to 0.35 second between them, or the chew notes are lower pitched (fundamental below 1.2 kilocycles). The chew note especially resembles the comparable note of the call of *Colaptes auratus* (Short, 1972), but it is shorter, and when alternating with wi notes in a full Wicka Call the two elements are not connected as they often are in the Wicka Call of *Colaptes auratus*. The call seems to be a variable agonistic call as it is in *Colaptes*.

The Long Call (fig. 21d-i) is a four to 16 note series, the equivalent of the song of songbirds. The call averages 1.14 second in duration (0.33 to 2.00 seconds in 20 calls analyzed), and contains an average of 9.47 notes per call delivered

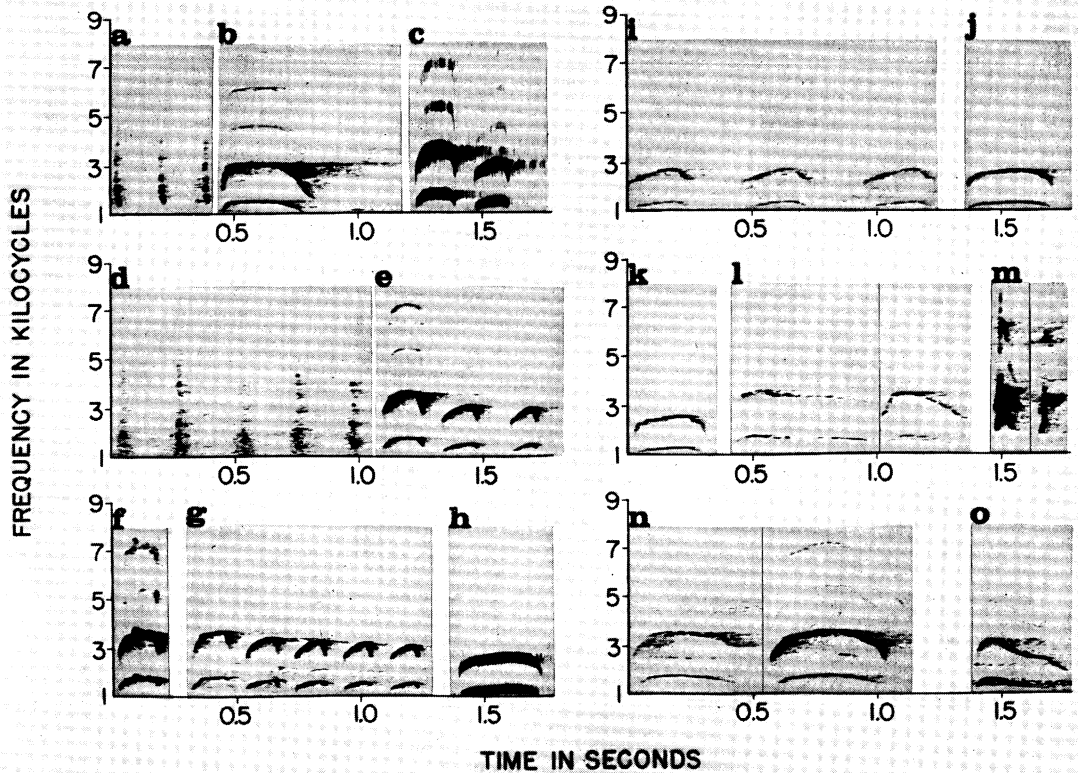


FIG. 22. Sound spectrograms of *Celeus brachyurus* and some species of *Picus*. a. Wicka Call of *Celeus brachyurus*, 3 ti notes from long series, Malaya. b. Most of a Kwee Call (tail cut off slightly) of *Picus miniaceus*, Malaya, adult at nest. c. Pee-bee Call, 2 notes, female *P. puniceus*, Malaya, WB. d. Wicka Call of subadult *P. vittatus*, part of a long sequence showing here consecutively a type A note, type B note, type A note, type B note, and an intermediate type B-C note, Malaya. e. Pee-bee Call, 3 notes, *P. puniceus*, Malaya. f. Initial, peaked variant note of 3-noted Pee-bee Call of *P. puniceus*, Malaya. g. Pee-bee Call of *P. puniceus*, 5 notes, Malaya. h. Sixth note of 11-note Long Call of *P. puniceus*, Malaya, WB. i. Notes 8 to 10 of a 22-note Long Call of *P. puniceus*, Malaya. j. First note of 3-noted Long Call of *P. puniceus*, Malaya. k. Third note of 4-noted Long Call of *P. puniceus*, Malaya. l. Two examples of Peew Call of *P. chlorolophus*, Malaya. m. Two examples of Pook Calls of *P. mentalis*, Malaya. n. Two examples of Peew Call of *P. chlorolophus*, India. o. Keek Call of *P. mentalis*, Malaya. Note that m is 1 kc. lower in pitch than indicated on figure. All sonagrams are narrow band unless indicated wide band by WB.

at an average rate of 8.97 notes per second (range 7.2 to 12.0 notes per second). The individual notes are shallow, inverted U-shaped notes, and many of them, including most initial notes of a call, are compound (double peak with depression between; note elongated) or at least have a distinct, tiny sub-peak arising from the peak near its end. Initial notes are higher pitched (peak of initial harmonic tone 3.0 to 3.7 kilocycles, higher in all cases than the 2.5 to

3.5 kilocycle terminal note) and they are longer (0.07 to 0.14 second in duration versus 0.025 to 0.040 second) than the terminal notes (fig. 21d, e). There tends to be a general, downward trend in pitch throughout the call, but the overall drop is only from 0.1 to 0.6 kilocycle. Each peak is emphasized usually in the initial harmonic tone, and most sound is encompassed within 0.2 kilocycle of that peak. Other harmonic tones are very weak, as is the fundamental tone; however,

three of 20 calls that I analyzed had a fundamental tone nearly as intense as the initial harmonic tone. Finally, the notes tend to be connected by a plateau of sound extending beyond the peak of each note; in three of 20 instances, all somewhat distant calls, these extensions so blurred the notes as to form a continuum, making it impossible for me to distinguish individual notes on the sonagrams. The Long Call clearly is a "song," that is, a territorial proclamation call. It also probably serves as a distant contact call between members of a pair. It is uttered sporadically, usually repetitively in bursts of several to 10 or 12 calls between foraging bouts. Mildly disturbed birds may emit this call in an apparently aggressive context, directed at an intruder, such as another woodpecker landing (and calling) nearby. I witnessed several cases of this reaction to nearby calling Laced Green Woodpeckers, Common Goldenbacked Woodpeckers, and Buff-rumped Woodpeckers.

WHITE-BELLIED WOODPECKER

Dryocopus javensis

The widespread genus *Dryocopus* is represented in southern Asia by the White-bellied Woodpecker, which ranges from India to China, Korea, Indochina, Sundaland, and the Philippines. The second largest southeast Asian woodpecker after the Great Slaty Woodpecker, the White-bellied Woodpecker is much more of a "woodpecking" species than is the Great Slaty. Its noisy excavating and tapping are louder than those of other woodpeckers in the region it occupies. The habits of this species resemble considerably those of its better known Eurasian relative *Dryocopus martius* (see Blume 1956, 1959, 1961, 1962, and Cuisin, 1967, 1968), with which it will be compared.

White-bellied Woodpeckers feed individually, or sometimes in pairs, although not usually close together. Almost all the foraging I observed was in dead stubs of live trees, dead trees, and large fallen logs, although possibly these observations reflect their noisiness in tapping at such sites. They favor primary forests, and forest edges, but they forage over great distances, including secondary forest bearing large trees, and cleared areas with scattered large trees. They are most common in wet primary forest having many dead or dying trees. Foraging occurs largely in middle and upper levels of forest trees, but long

feeding bouts were observed low in rotted stumps and in broken, dead trees. At a favored site a bird may forage for as long as an hour, moving very little. I saw no feeding on saplings or in smaller live trees, but dead trees no thicker than 12 centimeters were utilized by this woodpecker for foraging.

Foraging modes of the White-bellied Woodpecker include chiefly tapping, and excavating, and to a lesser extent probing and prying. In well-rotted logs or stubs, the woodpecker taps sporadically, then tongues food from within the opening made, or it taps in short bursts, gouging large openings in the wood. Less rotten wood is subjected to excavating action, with holes hewn out to various depths and widths. Well-worked stubs bearing diversely sized (up to 20 cm. in diameter, 8 cm. deep) pits, resembling those made by *Dryocopus martius* in Austria and *D. pileatus* in North America (personal observ.), were seen sporadically in forests occupied by *D. javensis*. I saw one male hack large (8 to 10 cm. in diameter) pieces of bark from a recently dead, large tree, working at 30 meters and upward for 15 minutes. Blows were delivered from the side, in the manner of *Dryocopus pileatus* (personal observ.) and *D. lineatus* (Short, 1970) until the pieces of bark were loosened, then a tangential probe-tap pried them loose. I watched a male excavate three cavities in the dead branch of a tall, live tree. The male then flew, and, shortly thereafter, a female appeared and worked at one site of excavation by the male, and at two other sites she excavated herself. Especially favored sites, such as a 1-meter-thick rotten, broken-off tree, were visited daily by (apparently) the same bird. One male fed for over one hour on each of three mornings at this tree, and he visited it on at least one afternoon as well. The birds feed on wood-boring beetles and ant pupae according to Ali (1953, p. 209).

Roosting sites of male and female are apart. One male drummed for long periods each evening near a roosting site in Malaya. Often, there was an answering drum from nearby (out of sight). At about 6:30 P.M. the male entered its roosting cavity in a rotten, tall, dead stub 200 meters outside a primary forest, in secondary forest, during March. This was the male that apparently lost its roosting tree to a male Great Slaty Woodpecker (which see).

There is no Malayan record of the nesting of the White-bellied Woodpecker, which nests

from February to May in Burma (Smythies, 1953). I located an apparent nest about 15 meters up a thick dead stub standing 100 meters from primary forest in a freshly cut-over area near Kuala Lompat in early March. On March 3 a male worked at the entrance and just within the cavity between 9:10 A.M. and 11 A.M., and was there also at 2 and at 3:30 P.M., so it probably excavated for most or all of six and one-half hours. I saw the female at the top of this stub on March 3, but she did not venture down to the nest cavity. On March 4 the male was working inside the nest entrance at 3:30 P.M. At 4:18 P.M. a female flew in and landed about 2 meters below the male—immediately the male began a low, rapid tapping beside the opening of the nest, holding his head downward (not drawing it far up as in normal drumming). This demonstration tapping lasted 90 seconds, and was followed by the female moving up to the entrance, at which the male flew off. At 4:26 P.M., and for 15 minutes thereafter the female worked “half-heartedly,” tapping a little at the sides of the entrance tunnel, and tossing out wood chips. Unfortunately, when I returned to the area in early April the dead trees, including the nest tree of the woodpeckers, had been felled, and the birds were not in evidence. Demonstration tapping is known in the Black Woodpecker (references above).

No obvious displays were observed, although the crest of the male seemed raised partly to moderately whenever one drummed or called. Comparative studies of the displays of the White-bellied Woodpecker and the Black Woodpecker would be rewarding.

Aside from demonstration tapping, seen twice, drumming is common, and its loudness makes it distinctive among drums heard in lowland forests. Drumming bursts are short to long, typically commence slowly, and terminate more rapidly. The members of a pair frequently indulged in short drumming bursts during the time of my visit, at a rate of three drums and responses per minute. Seven recorded bursts (fig. 20a) contain four to 28 beats delivered in 0.28 to 1.90 seconds, at an average rate of 12.8 to 15.8 beats per call. Longer drums (18 to 28 beats, $N=5$) start at a rate of 11 to 12 beats per second, then increase to a terminal rate (last 0.5 second) of 16 to 19 beats per second. This contrasts with data for *Dryocopus martius* in Europe (recordings of three drums supplied by D. Blume from Ger-

many, and data from Seilmann, 1959, p. 28). The Black Woodpecker drums in long series of 32 to 44 beats in 1.87 to 2.69 seconds, at a rate of 16 or 17 beats per second. The three examples from Blume show a rise in tempo from 16 to 18 or 19 beats per second from the initial to the terminal half second, an increase in rate of less than 20 percent compared with an increase of between 45 and 72 percent in five calls of *D. javensis*. Thus, the drums of the latter are slower generally, but especially initially, compared with *D. martius* (terminal portions of drums of the two species are virtually identical). Drumming occurred sporadically throughout the day, but was most prevalent in late afternoon and early to midmorning. A foraging bird usually paused at the end of its feeding at a given site to drum four or five times, and to preen. If a response occurred, a drumming bout of 15 minutes or more ensued. In late afternoon individual White-bellied Woodpeckers of both sexes sought drumming sites, usually high in a tree or in an isolated stub, and there alternately drummed, preened, and sunned themselves. Distant drumming responses resulted in bouts up to 45 minutes in duration. No close responses were heard, and the bouts are thought to have been between mates, or distant birds on their own territories, because responses drew no strong reaction and resulted in no apparent “excitement” on the part of the bird under observation—rather there was greater persistence resulting in a longer-than-usual session of drumming. (See fig. 23 for body movement in drumming.)

One male White-bellied Woodpecker utilized about 20 drumming sites, moving about the limbs of a dead tree at Pasoh, Negeri Sembilan, Malaya. This bird finally concentrated its drumming at the edge of a cavity previously excavated by a Crimson-winged Woodpecker. Between drumming episodes the male sporadically, but at times intently worked at the edges of this cavity, whacking out pieces of wood. This occurred for nearly an hour on at least two afternoons over three days in March, resulting in the enlargement of the opening—after this no Crimson-winged Woodpecker was seen in that tree. As noted in the discussion of the latter woodpecker, the branch bearing the cavity was much too small to contain a cavity suitable for the roosting or nesting of the White-bellied Woodpecker. The net effect of the action of the White-bellied

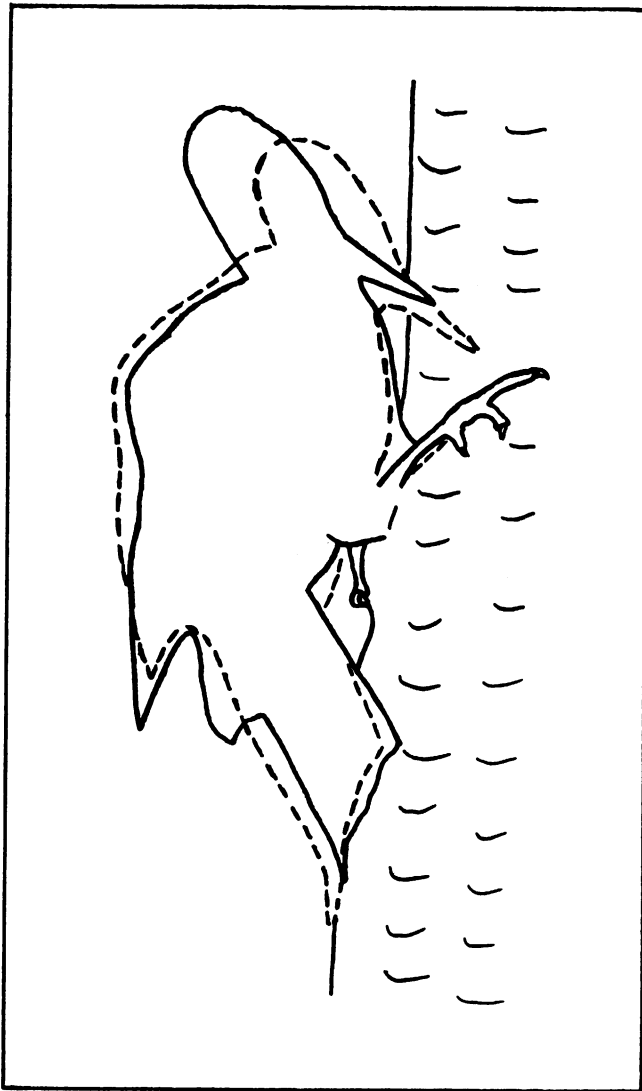


FIG. 23. Drumming male White-bellied Woodpecker (*Dryocopus javensis*), Pasoh, Malaya. Drawn from 2 consecutive frames of 16 mm. movie film taken at 24 frames per second, initial frame in black followed by next frame, dashed line. Black line indicates recovery position, dashed line, percussion position. Note that wings are pulled in, back raised, chest expanded, tail appressed and stretched, legs straightened (not shown, but feet also clasped more tightly), and bill and head thrust downward from recovery phase to percussion phase. Bird is about 45 cm. long.

Woodpecker then was to render the cavity unusable by the Crimson-winged Woodpecker.

Further study of the vocalizations of *Dryocopus javensis* is needed to permit a detailed comparison

with the calls of *Dryocopus martius*, as documented by Blume (1961) and Cuisin (1967). I heard three groups of calls by *D. javensis*, including a variable single to double note, a low Wicka Call,

and a short to long series of notes, or sometimes a series of double notes uttered while the bird is perched or in flight. The single note presumably corresponds to the chiank note reported by Ali (1949), who also noted (1953) a laughing call uttered on the wing. Smythies (1953, p. 307) reported a "soft quuk note," possibly a wicka-like call.

The single note or call note of *Dryocopus javensis* varies from a fast sharp "kuk" (or "kik") through a "kyuk" to "kew," then "kyow," and finally a double-noted "kee-yow" or "pee-aw." Sonagrams show these to constitute a graded series of increasing duration, and with a shift from a more vertical ("kuk") to a more horizontal ("kee-ow") form. These notes seem to represent the counterparts of the Kjah, Kijah, and Klik-je calls (Blume, 1961; these are the Klieu and Kik calls of Cuisin, 1967). I designate the complex as the Kew Call, as this was one of the commonly heard versions, and it also represents a rather intermediate form between the extreme kuk and kee-ow versions.

The various forms of the Kew Call (fig. 15g, j, and k) all are inverted U-shaped notes skewed weakly (short notes) to strongly toward the initial part of the note, that is, rising rapidly and falling more gradually from a peak occurring near the beginning of the note. Shorter notes (kuk, kyuk) show a skewed, inverted U-shaped form, with a tail of sound extending beyond the peak (dominant tone) and often from the emphasized dropping leg of the note. Longer notes (kyow, kee-ow) resemble the shorter notes in form but taper downward more gradually, and they have an extra element, an extra dropping segment paralleling and following the dropping terminal segment of the inverted U. Intermediate (kew) notes are of intermediate length and either have or lack the extra dropping element. An initial vertical element, weak to moderately intense, introduces many notes of all the forms. In all forms of the Kew Call the peak of the fundamental tone is between 1.2 and 1.4 (usually about 1.3) kilocycles, and the peak of the dominant, initial harmonic tone is at 2.5 to 2.8 kilocycles. Other harmonic tones are weak, although a subdominant peak is evident occasionally at 3.5 to 4.0 kilocycles, and some notes show subdominant, terminal dropping legs of higher pitched overtones. Most sound in the calls is pitched between 1.0 and 2.8 kilocycles.

The kuk version (fig. 15g) of the Kew Call is

about 0.05 second in duration, or up to 0.2 second including the sound tailing beyond it. In the two calls analyzed, the most intense sound is at the peaks of the initial harmonic tone. The kyuk version (fig. 15j) is longer (0.07 to 0.08 second in duration, and up to 0.3 second including the terminal tail of sound) chiefly because of skewing such that the dropping leg following the peak is more gradual than in the kuk version. Emphasis mainly is on the peak and dropping parts of the initial harmonic tone, although the peak of the fundamental tone is nearly as loud in two of four examples analyzed.

Fourteen calls representing the kew version (fig. 15k) of the Kew Call show a duration of 0.11 to 0.15 second, ranging to 0.35 second including the terminal tail of sound. In at least 10 of 14 cases there is at least a trace of the parallel, dropping element following the inverted U-shaped note. Also, half the calls analyzed, instead of ending the inverted U at the low point of the dropping leg, show a tendency to continue as a plateau at that point. It is this continuation, the additional dropping element, and the greater skewness of these notes that are responsible for their greater duration compared with the shorter versions. Emphasized in kew notes are the peak of the initial harmonic tone, a portion or all of its gradually dropping portion, the additional parallel dropping element in most cases in which it is present, and the tailing of sound beyond the peak and the parallel dropping element in that dominant tone. The peak of the fundamental tone is weaker than in shorter versions of this call.

The kyow version (fig. 15k) of the Kew Call is still longer than the kew version, lasting from 0.16 to 0.20 second (with terminal tail, to 0.40 second). Sixteen examples all have a parallel dropping element appended to the basic inverted U of the call. Most either form a concavity at the base of the dropping leg, or have a step before the end of this leg. With or without that step, the dropping portion is more gradual than in shorter versions, thus lengthening the note. Most emphasis is on the peak and dropping portion of the initial harmonic tone, on the additional dropping element, and on their "tails."

Four notes intermediate between kyow and kee-ow versions are 0.20 to 0.22 second in duration (fig. 15k) and have characteristics like kyow notes. The one of these that is figured shows

moderate emphasis on dropping portions of higher harmonic tones (e.g., at 5.5 kilocycles) and on part of the initial vertical element at 7.0 kilocycles; most sound nevertheless is contained within the initial harmonic tone, that is, between 1.0 and 2.6 kilocycles.

The kee-ow version (fig. 15k) is even longer, lasting 0.24 or 0.25 second in four examples. The greater length of these notes does not involve a lengthened, inverted U-shaped element, which is no longer than that in the kyow version, but is caused by a prolonged base of the end of that note. That is, the dropping leg, at its bottom, extends at a constant pitch, giving the "ow" effect of the note. The pitch and emphasis of these notes are the same as for the kyow version.

The longer versions of the Kew Call bear a close resemblance to the terminal, dropping portion of the Tiak or Kijak Call of *D. martius*, although the latter call drops more sharply and usually is slightly higher pitched. These calls seemed to function in *D. javensis* much as do the call notes of other woodpeckers, namely as low to moderate intensity alarm-agonistic notes perhaps also bearing a localization element. A foraging White-bellied Woodpecker interrupted by my intrusion often uttered Kew Calls. If mildly alarmed, it resumed sporadic, perhaps stilted foraging, calling kuk or kyuk frequently and keeping an eye on me. If unduly alarmed, it continued to progress up the tree on which it had been foraging, or flew to another tree farther away from me, calling kew, kyow, or infrequently kee-ow. My impression was that these longer Kew Calls expressed greater aggression toward me because it was disturbed at a favored foraging site, rather than because of heightened alarm. The woodpecker usually flew off after uttering longer Kew Calls, and then I would hear it calling kyuk or kew repeatedly. There was a decided association of versions of the Kew Call adjacent to one another in the spectrum, that is, kuk calls were interspersed with some kyuk calls, the latter with kew, or kuk calls, and kew calls occurred with kyuk or more commonly with kyow calls. The kee-ow version of the call was an exception, in that it occurred intermingled with kuk and kyuk, with kew, or with kyow calls, showing no prevalent association.

A low Wicka Call heard twice from apparently paired birds resting together on a stub was not accompanied by obvious displays, although one bird moved to one side in an (unritualized)

sidling motion. The call, an "a-wi, a-wi" or "ch-wi, ch-wi" is presumably the equivalent of the Klik-je Call of the Black Woodpecker (Blume, 1961), but of course further study must be undertaken to establish this. Unfortunately it was raining at the time and I had no tape recorder, so did not record this vocalization.

The Black Woodpecker (*D. martius*) has a distinctive flight call, the Kyrr Call (Kru Call of Cuisin, 1967, or Kürr Call of Blume, 1961), which seemingly has no counterpart in *Dryocopus javensis*—or in the New World *D. lineatus* and *D. pileatus*. Rather, the White-bellied Woodpecker utters its Long Call (Quic Call of Cuisin, 1967, or Kwik Call of Blume, 1961) either in flight or when perched, as do the New World species (personal observ.). The Long Call of *D. javensis* is a series of notes, variable in length and in the number of notes contained. The notes are inverted, U-shaped, 0.03 to 0.045 second in duration, considerably shorter than the somewhat U-shaped notes of certain Long Calls of *D. martius* [six calls, notes 0.06 to 0.16 second in duration and slightly shorter than short notes in Long Calls of *D. pileatus* (notes 0.05 second or longer in duration)]. Whereas the calls of *martius* are regular with notes uttered at about 3.95 to 5.15 notes per second (there is a slight speed-up during five of six calls analyzed), those of *javensis* are highly irregular in their spacing, with notes as variably apart as from 0.03 to 0.18 second within the same call. Another characteristic of many Long Calls of *javensis*, noted occasionally in such calls of *D. pileatus* but not in *D. martius*, is the occurrence of double and triple notes (figs. 20g, h) irregularly spaced amid single notes. The compound notes have individual notes (actually elements) of the call directly connected at the bases of the legs of the inverted U, or they are very close together compared with the distance among single, double, and triple notes.

The inverted, U-shaped notes peak at 2.2 to 2.8 kilocycles in the dominant initial harmonic tone, and at 1.1 to 1.5 kilocycles in the weak (occasionally lacking) fundamental tone. A few notes show a flat top, or angle at the end of the peak, reminiscent of the (longer) flat-topped notes of many calls of *D. martius*. There is little variation in pitch within a given call, and only two of eight calls analyzed show a distinct downward trend in pitch throughout the call (from 2.4 to 2.2, and from 2.8 to 2.4 kilocycles in the

dominant tone of the two calls). In comparison, the notes of the Black Woodpecker's Long Call have the fundamental tone dominant, peaking at 2.0 to 2.5 kilocycles, and a weak to moderate initial harmonic tone peaking at about 4.0 kilocycles. Many calls of *martius* are not inverted U-shaped but rather rise to a peak, which then form a long plateau, with no drop at the end. The notes generally are connected strongly by sound continuous at the peak of the fundamental tone (there is a much weaker, tailing effect in the shorter, U-shaped notes of *javensis*). Even the U-shaped notes of some calls of *martius* stress the fundamental tone, and they show a curiously wavering effect as if multiple peaked, recalling the appearance of the Kjah Call and the Kyrr Call of *martius* (both these calls have not been heard from *javensis*). Long Calls of *D. pileatus* contain inverted, U-shaped notes slightly longer than those of *javensis*, and showing overtones with stress on one of those at about 3.0 kilocycles. Overall, the Long Calls of *martius* and *javensis* are very different, much more so than are the Long Calls of *pileatus* and *javensis*. The implication of this and of other vocal data is that *javensis* has diverged less from the common (Old World) ancestor of *javensis* and *martius* than has *martius* (*Dryocopus* almost certainly arose in the New World as an offshoot of an ancestor in common with *Celeus*; *Dryocopus galeatus* of South America is almost intermediate between *Celeus* and *Dryocopus*).

Long Calls of the White-bellied Woodpecker vary in duration. Those analyzed show a duration of from 0.47 to over 5.0 seconds (latter incompletely tape-recorded). I heard calls over six seconds in duration, fully as long as longer calls of *D. martius*. The latter species, however, normally utters very long (e.g., 3.70 to 6.40 seconds in duration, six calls analyzed from Germany, courtesy of D. Blume) calls, whereas many shorter Long Calls of *javensis* were heard (*D. pileatus* varies likewise in the length of its calls). The longest tape-recorded call of *javensis*, over five seconds in duration, was uttered by a male as it left its perch and flew away. Shorter calls were uttered in flight or while the bird was perched. Of the three very short calls analyzed, those containing five or six notes, two were composed of single notes, and one contained four single and one double note (fig. 20g). Calls containing only single notes, and therefore easily analyzed as to their tempo, showed 11.5 to

13.3 notes per second, a rate more than double that of *martius* (*pileatus* is intermediate, but the tempo generally is nearer that of *martius*).

Long calls uttered were: by lone birds sporadically after foraging for awhile; early in the day and occasionally all during the day by pairs, one responding to another in a bout lasting two or three minutes; by birds startled by my approach as they flew away; and by flying birds passing overhead, apparently triggered by sight of me. I surmise that this call functions as a territorial call (hence agonistic in function), and as a localization call informing the mate of its location. In regard to the latter function, studies are needed to compare the Long Call and drumming, both of which can be heard for long distances.

BANDED RED WOODPECKER

Picus miniaceus

The Banded Red Woodpecker is a rather stolid, Sundaland species ranging north into Tenasserim and southern Thailand, and occupying somewhat diverse habitats from mangroves and coastal scrub at sea level to forested mountain slopes. It is, however, decidedly uncommon everywhere except in primary forest where it is numerous, although inconspicuous. This woodpecker forages alone, or perhaps more frequently in pairs, the male and female often feeding side by side. Such social foraging habits are extreme among the woodpeckers that I encountered, the closest approach being found in *Celeus brachyurus* and in the genus *Meiglyptes*. Banded Red Woodpeckers forage at all levels in forest trees, from fallen logs and stubs, to vines, trunks, epiphytes, and branches of large trees. Most authors have noted them at fairly low levels in the forest but I suggest that this is the result of their inconspicuousness when foraging high in the trees. Unlike *Picus puniceus*, the movements of *Picus miniaceus* are slow and deliberate, with foraging concentrated at rather few sites where the bird (or pair) is occupied for long periods. They deliver light taps, particularly in rotted stubs, and broken branches, or they may perch, quietly probing into the bases of epiphytes. When feeding at a site their taps are methodically delivered, with pauses interspersed, and these often are of long duration as the bird or birds perch quietly surveying their surroundings. They tend to prefer dense vegetation, vine-covered trees and stubs,

and other sites in which their lack of movement insures concealment. Foraging modes include tapping, probing, and gleaning, and their actions rarely are noisy. The only food mentioned in the literature and on specimen labels of Banded Red Woodpeckers is ants, and the woodpecker obtains these both on the surface of the bark and within rotten wood.

Nesting occurs in March in Malaya. A pair worked, at times side by side carving out a cavity at the vine-obscured top of a stub 20 meters above ground on March 4 at Kuala Lompat in Pahang. On March 5 the male excavated from 9:40 to 9:50 A.M. with the female beside it, occasionally pecking at the entrance to the cavity. At 9:50 the male entered the cavity; the female remained outside quietly for five minutes, then flew away. At 10:05 the male appeared at the entrance to toss out wood chips, and at 10:12 he left the hole, backing out of it. He then reentered, and exited several times in succession before disappearing inside, where he remained until 10:36, occasionally reappearing to throw out wood chips. At 10:35 the female flew to the cavity, and a minute later the male, bearing wood chips in its bill, flew out, and gliding downward in a floating flight during which he fluttered weakly several times, took a curving course, disappearing into the understory 50 meters away. The female then entered the cavity and worked inside at least until 11:40 A.M. sporadically tossing out chips. I saw the gliding flight three times, all performed by the male departing from the nest in the presence of the female. The male roosted in the cavity on the nights of March 4 and 5, departing the presumed nest at 7:12 A.M. the following mornings. The morning departure was preceded by two or three single Kwee Calls, delivered after 7:00 A.M. by the bird with its head partly out of the hole, and it was followed by four or five kwee or kweea notes from a nearby perch after he left the nest. The female did not appear and I heard no response to his calls. Unfortunately the nesting attempt was unsuccessful, for there was no activity at the cavity in early April when I returned to the area.

The Gliding Flight of the Banded Red Woodpecker has been described above. Other visual displays include Crest Raising, and Swinging involving the head and body. On February 13 two males and two females interacted, sex for sex, high in forest trees in Negeri Sembilan. The

two females were rather quiet, and gave slight swings of the head perched close to each other, although one chased the other when the males engaged in a chase. The males moved about over a horizontal limb, spiralling in a chase *à pied*, both with crest raised (the crest of the aggressor more fully), and with head and body swinging and Wicka Calls (see below). The encounter was brief, as the birds soon flew, one male closely pursuing the other. Encounters at the nest site (see above) were not marked by detectable displays or discernable vocalizations, other than the Gliding Flight Display noted above. I did see one interspecific encounter between a male Banded Red Woodpecker and a male Crimson-winged Woodpecker. These two were foraging, the Banded Red at a broken spot on a tree trunk, and the Crimson-wing moving upward on the trunk. Both birds showed a slightly raised crest as the Crimson-wing approached; the latter then moved out of its line of ascent and headed directly at the Banded Red Woodpecker, which turned away, and flew up into the branches of the tree. I saw these two species foraging in the same or adjacent trees several times, and noted a heightened incidence of calling by both under such circumstances, although this act of supplanting was the only encounter observed.

Vocalizations of the Banded Red Woodpecker include a basic Kwee Call, delivered singly or in series of up to seven notes, a Keek Call, and a Wicka Call. I was unable to tape-record the infrequent series Kwee Call, and I recorded only poor examples of Keek and Wicka calls. There was no evidence of drumming by this woodpecker.

The Keek Call is a single note delivered alone or in loose, irregular series. Each note is 0.15 to 0.20 second in duration, consisting of a horizontal or downward tending element with emphasis mainly on the initial harmonic tone, or equally on the fundamental tone (peak at about 2.0 kilocycles) and the initial harmonic tone. Details of the structure of this note are not clear, but one Keek Call interjected among low Wicka Call notes between two birds (pair) shows a double-peak tendency with an initial rise in the first harmonic tone from 2.4 to 3.5 kilocycles, an abrupt drop to 2.7 kilocycles, then a rapid rise to about 3 kilocycles followed by a gradual downward trend in pitch (to 2.5 kilocycles). The function of this call, which is like the Keek Call of *Celeus brachyurus* in pitch but is much more horizontal, is unknown.

Wicka Calls or those assumed to be homologous to Wicka Calls in other picids were generally faint and not heard adequately. The loud calls accompanying Swinging Displays in the agonistic encounter between two males (described above) were not recorded, but are rendered in my notes as: "Kwi-wi-ta-wi-kwi," "pwi, pwi, pwi, pwi," and "pe-wew, pe-wew, pe-wew." All the low Wicka Call notes that I recorded are of the "wi" type, that is, short inverted V-shaped notes peaking at about 3.5 kilocycles (dominant harmonic tone) a trifle longer (0.02 to 0.035 second) than those of *Celeus brachyurus*. In series these notes are about 0.23 second apart, thus rendered at a slower rate than in *Celeus brachyurus*. None of the "chew" alternate notes of the Wicka Call were recorded, although those heard sounded like the "chew" notes of Wicka Calls of *brachyurus*. The calls of these species should prove functionally similar.

The Kwee Call, a single or series call, was recorded only singly (fig. 22b), but the notes sound virtually like those of long Kwee Calls. The note is a long, inverted U-shaped note with a rapid or even sharp initial rise to a peak that plateaus before dropping off gradually; at the point where the drop commences, a tail of sound continues on for a variable time at the same pitch as the plateau. Emphasis is on the initial harmonic tone (plateau at 3.1 to 3.2 kilocycles in seven examples), and to a lesser extent on the fundamental tone (plateau at 1.5 to 1.7 kilocycles); other harmonic tones are very weak. The initial rise in the dominant harmonic tone is from 2.3 to about 3.2 kilocycles, and the terminal, gradual drop is from the plateau to a pitch below that of the fundamental tone. The notes are 0.35 to 0.42 second long (seven examples) from initial rise to terminal drop, but with the extension beyond the inverted U, the call is 0.45 to 0.80 second in duration (see *Picus puniceus* and *Picus chlorolophus*). I saw a kwee-calling bird pointing its head almost vertically as it rendered the (single) call on four separate occasions, but I was not close enough to ascertain whether or not the posture was identical with that of *Picus puniceus* (see below), although it seemed very similar.

I heard no long series call comparable with the Long Call of *Celeus brachyurus*, or of the *Picus vittatus-canus* group. It appears that *Picus minia-ceus*, *Picus puniceus*, and probably *Picus chlorolophus* utilize a single kwee note to form series

(long) calls, but it is possible that they have little-used, undescribed calls more like those known for these other species.

CRIMSON-WINGED WOODPECKER

Picus puniceus

This species ranges through Sundaland north to Tenasserim and southern Thailand, in lowland primary forest and taller second-growth. It extends into hills, especially in regions where the closely related *Picus chlorolophus* is absent. Foraging singly, but maintaining contact with its nearby mate (which may be in an adjacent tree or farther away), the Crimson-wing prefers the trunk and major branches of large and small trees. It usually is seen in the upper portions of trees, but I have observed it in a tree in an orchard within 3 meters of the ground. One male foraged for a half-hour in the tops of three tall trees (over 30 meters) standing above second-growth woods. *Picus puniceus* seems attracted to tall trees standing alone, or emerging from second-growth beside primary forest, and the species seems most common at the edges of forest bordered by scattered tall trees. Foraging rarely takes place in small branchlets and leaf clusters, but rather is restricted to the bark and crevices in trunks and branches of trees.

The food of *puniceus* seems to be exclusively ants and termites (Smythies, 1960). These are obtained by tapping, probing, excavating, gleaning and prying, in that order, on the bark of trees. Crimson-wings usually commence feeding midway up the trunk of a tree, or higher, working rapidly up the trunks and along one or more branches. Following a major branch to its termination high in the tree, they often pause to call from such a site before moving to another tree. They forage at rough places in the bark, especially where there are lichens. Long periods of work at one site occurred only at a few bases of broken branches. In one instance a female tapped, excavated, and extracted insects (possibly ants) from such a break for one and one-half hours with movement confined to an area of 20 square centimeters. At sites of this type the woodpecker taps and excavates, prying and probing somewhat, then inserts the bill and presumably the extensible tongue, "tonguing up" insects (almost surely ants) for long periods without further action of the bill. Usually, Crimson-wings do not remain in one place, but

move rather rapidly, methodically covering the bark of certain trees. It is more active than *Picus miniaceus*, but less active than its other sympatric congener *Picus mentalis*, which see.

Smythies (1960) mentioned a female *Picus puniceus* at a nest containing three eggs in Borneo, but did not describe the nest site. I located no definite nest, but in January, 1972, a male Crimson-wing excavated a cavity about 25 meters up in a high stub of a dead tree standing above second-growth in Negeri Sembilan (D. Wells, personal commun.), and the male was using the cavity as a roosting site during my visit on February 12 to 16. On several mornings the male called from the entrance of the cavity for a half-hour, then left. Evenings it called nearby before retiring to the cavity for the night. There is no indication that this was to be a nest, for I never saw a female near it. When I returned in March, I found that a male *Dryocopus javensis* was using that tree for drumming and preening, usually late in the day. This woodpecker devoted some time to the cavity, which had been excavated by the Crimson-winged Woodpecker, mainly sporadically pecking at the entrance that was enlarged somewhat (the dead branch itself was but 20 centimeters in diameter, much too small to bear a roosting or nesting cavity of *Dryocopus javensis*). I did not again encounter the Crimson-wing in that tree. Two other roosting holes were discovered, both occupied by only one bird (no other Crimson-wings in the same or adjacent trees), and both 20 meters or more above ground.

I saw few displays of *Picus puniceus* (see *Picus miniaceus* for an interspecific encounter with *puniceus*). Crest-raising is prevalent and conspicuous, as in *Picus chlorolophus*, *Picus flavinucha*, *Picus mentalis*, and to a lesser extent, *Picus miniaceus*. The crest is erected particularly during the Pee-bee Call (see below); the bird points its bill skyward nearly vertically, then simultaneously erects its crest, raises its head even more, and calls. One pair perched together (rarely were two birds seen in the same tree, and only once did I encounter two birds perched side by side), the male drummed, then both called ("week-eek," possibly a Wicka Call) as they faced one another, Bill Raising, then Swinging the body and head with the crest raised. After this brief bout the female departed.

I heard several drums positively ascribed to this woodpecker. The male mentioned above as

having excavated a cavity drummed thrice outside the entrance to the cavity. The male displaying with a female, just discussed, drummed rather weakly. Three other instances were noted, all involving weak drumming. I recorded on tape only one burst of drumming, that by the male displaying to a female. This burst was 0.9 second in duration, and contained 14 beats (15.6 beats per second). The beats were equally spaced, except that the last beat was delayed slightly. There is variation in the intensity of the beats of drumming burst of Crimson-wings although there is no regular pattern. The recorded drumming burst had a loud initial beat followed by weaker beats, a stronger seventh beat, and then strong beats following a weak eighth beat. Drumming may function diversely in *puniceus*, for lone drumming birds were noted at dead stubs (possibly territorial proclamation or location call) in addition to use during a heterosexual encounter.

Four distinct vocalizations were heard, and three were recorded. A low "week-eek" burst during the encounter between a male and a female was not tape-recorded; it very likely was a Wicka Call or its equivalent.

Single Peew Calls (fig. 21n) were heard infrequently and but one was recorded on tape. This call is lower pitched and shorter than the Peew Call of *Picus chlorolophus*, the close relative of *puniceus*, but like many examples of that call of the latter it is a symmetrical, inverted U-shaped note emphasized in the initial harmonic tone with a plateau at 3.2 kilocycles. The fundamental tone is much weaker than in *chlorolophus*, and the other harmonic tones are extremely weak. The note is 0.25 second in duration for its basic inverted U, with a weak extension continuing at 3.2 kilocycles (for 0.40 second or more, making the total duration 0.65 second) beyond the point at which the plateau drops. In the example analyzed the concentration of sound is on the plateau, that is, on the flat top of the inverted U, with a much weaker initial rise from 2.5 kilocycles, and an equally weak terminal drop from 3.2 to about 2.5 kilocycles (fig. 21n). I did not hear the call often enough or under circumstances allowing me to comment on its function, but presumably it functions somewhat as the homologous Peew Call of *Picus chlorolophus* and the similar if not homologous Kwee Call of *Picus miniaceus*.

The Pee-bee Call (fig. 22c, e-g) of *Picus*

puniceus was its most often uttered call, and the peculiar and characteristic call on which various authors (e.g., Smythies, 1960, p. 330) have commented. This somewhat variable call usually contains two to four notes, but five-noted calls occasionally are heard and rarely (possibly under circumstances in which the bird is disturbed) a single note may be uttered. The call is rendered in my field notes as "peeé-bee" or "seeé-boo," "peeé-dee-dee-dee," and "weé-kee-kee-kee-kee" for calls with two, four, and five notes, respectively. Foraging birds upon reaching the top of a tree may pause for five minutes or more to call intermittently during the day; occasional sessions of up to 20 minutes were noted. Usually morning sessions of calling are no more frequent and of no greater duration than those occurring through the day. However, long sessions of up to an hour marked the evenings; indeed wherever these birds are present their calls are a characteristic sound of the pre-dusk period. Perched atop a stub, or less conspicuously in an upper branch of a tree near the roosting site, a Crimson-wing calls often at a sustained rate of four to six times a minute for minutes at a time. There are pauses for preening, or to change perches, but then the bird resumes calling. One female called 45 times between 6:50 and 7:00 P.M.; then it preened for four minutes before flying to its roosting tree, and entering a cavity there. Occasionally evening calling periods were restricted to five- or 10-minute periods before dark, but usually these were of more than 20 minutes in duration. A calling bird raises its head, bill held almost vertically, and stretches its head upward, as noted above.

Of the hundreds of Pee-bee Calls heard, and the hundred or so recorded on tape, I analyzed 21 randomly selected examples roughly in proportion to the number of recorded calls having the various number of notes, namely five two-noted calls, three three-noted calls, seven four-noted calls, and three five-noted calls. Additionally two somewhat aberrant three-noted calls and one peculiar two-noted call were included. Calls of two to five notes respectively averaged these durations: 0.394 second (0.38 to 0.42 second), 0.633 second (0.62 to 0.65 second), 0.803 second (0.77 to 0.83 second), and 0.923 second (0.92 to 0.93). The notes in a given call generally resemble one another closely, except that the first and the last note often differ somewhat. All are inverted, U-shaped notes with strong empha-

sis on the initial harmonic tone, some emphasis on the fundamental tone, and very weak other harmonic tones. The initial note is higher pitched, and usually substantially higher pitched than (0.2 to 1.0 kilocycles above) the subsequent notes; it is invariably the longest note in a call. When other notes are skewed (toward the end of the note), the initial note is more flat-topped and less skewed. The terminal note is usually (18 of 20 cases) the shortest note in the call and is the lowest pitched (equal to or lower pitched than the preceding note).

Initial notes peak at 3.6 to 3.8 kilocycles (dominant harmonic tone) and are 0.14 to 0.18 second in duration excluding the terminal, variable tail that may continue beyond the peak of the note. Subsequent notes drop in pitch. There is a peak of 3.2 to 3.5 kilocycles for the dominant harmonic tone of the next note, except that there is a peak of 2.7 to 3.1 kilocycles for the terminal second note of two-noted calls, 3.0 to 3.5 kilocycles for the third note, 3.0 to 3.4 kilocycles for the fourth note, and 3.0 to 3.2 kilocycles for the fifth note, where present. Notes of a call also are progressively shorter, although middle notes of longer (four to five note) calls often are alike in duration. Terminal notes are 0.10 to 0.16 second in duration. In most shorter calls and some of the longer calls the notes are broadly inverted U-shaped, and flat on top, whereas many of the notes in longer calls are skewed, peaking late in the note. This is true especially of the short terminal notes of three- to five-note calls.

Several aberrant or unusual calls ought to be considered because their peculiarities may shed light on the structural relationship of vocalizations among species of *Picus*, and between calls within *Picus puniceus*. A three-noted Pee-bee Call is like other three-note calls in all respects except the initial note, in which the (fig. 22f) normal, inverted U-shape is distorted by irregular small peaks, perhaps four of them, but especially a peak one-third of the way through the note, rising 0.4 kilocycle above the "plateau." This peaked effect is pronounced in an aberrant two-noted call, the first note of which has a full, distinct, nearly terminal peak (intense at 1.5 to over 8.0 kilocycles). This initial note also is unusually low-pitched (3.0 kilocycles). The peak and its extension to a pronounced vertical element suggest a possible relationship between the wide keek, peew, and pee-bee notes of *Picus miniaceus-puniceus-chlorolophus* and sharp, vertical

“peek” notes of *Picus mentalis*, *Picus vittatus*, and other species of *Picus*. The only vertical, short note of *Picus miniaceus*, *Picus puniceus*, or *Picus chlorolophus* is the “wi” note of the presumed Wicka Call of *miniaceus*.

A peculiar three-noted Pee-bee Call of 0.85 second duration (longer than other three-noted calls, and indeed longer than any four-noted call) is characterized by flat-topped, essentially symmetrical, long notes. All three notes are longer (0.20 to 0.25 second) than other Pee-bee Call notes, and indeed the notes closely resemble the single element of the Peew Call. The two notes following the “peew”-like first note are shorter, and they tend to rise very slightly terminally, hence resembling very broad, Pee-bee notes. This particular call thus shows the relation of the Peew Call to the Pee-bee Call; the latter may be a derivative of the former. Also, the Long Call (see below) is composed of similar notes, and this aberrant call is intermediate between the Pee-bee and Long Calls in the rate and structure of its notes.

The Pee-bee Call seems to be a localization call, and probably a territorial (agonistic) call as well. By issuing continuous calls from its roosting site, and probably from favored foraging areas the Crimson-wing effectively signals other birds, including presumably its (prospective) mate, of its whereabouts.

The Long Call (fig. 22h-k) of *Picus puniceus* is a series of three to 22 notes that are essentially low-pitched, long Peew Call notes covering only a small range in pitch. The notes may be regarded also as low-pitched, long, non-skewed Pee-bee Call notes delivered at a much slower rate. Unlike notes of these other calls, the Long Call notes exhibit almost no tendency to extend or “tail” past the inverted U. The relation among these calls is shown by the aberrant three-noted Pee-bee Call described above; its notes are shaped like Long Call notes, but show evidence of the skewing of Pee-bee notes, and the call is a rapid one like the Pee-bee Call. Notes of the Long Call are uttered at a rate of 1.13 to 2.40 per second, generally more rapidly the more notes there are in the call, but one four-note call is 1.65 second in duration (2.4 notes per second). Ten recorded calls contained from three to 11 notes, with a duration of 1.65 to 8.0 seconds, and one 22-note call lasted 10.8 seconds.

Notes are more or less symmetrical, and in-

verted U-shaped, but there is a tendency toward a gradual rise contrasting with a sharp drop, particularly in initial notes. The initial harmonic tone with its plateau at 2.8 to 3.8 kilocycles receives the greatest emphasis; the fundamental tone is somewhat weaker and other harmonic tones are very weak. The initial note is pitched lower (e.g. 1.8 kilocycles rising to 2.7 kilocycles on the second note, 2.3 kilocycles rising to 2.7 kilocycles on the second note) in a few calls, but generally the peaks of the various notes within a call show little variation. Likewise, the initial note may be a trifle shorter in duration, but other notes are about of equal duration. One irregular call of four notes varied consecutively from 0.30, to 0.28, 0.30, and 0.35 second in the duration of the notes.

Irregularities in Long Call notes include a tendency for a step to form in the downward dropping terminal portion (two notes in two of seven calls analyzed), and, especially, a tendency for tiny peaks to form atop the inverted U. Two of seven calls show such peaked notes. In one call of four notes, the second and third notes have sub-peaks, and in the 22-note call, notes 7, 12, 14, and 16 have one to three sub-peaks. As in the case of this tendency in Pee-bee Calls, a relation is suggested to sharp-peaked, vertical notes like the “wi” element of Wicka Calls. Most Long Call notes have the sound encompassed within a $\frac{1}{2}$ kilocycle range within the loud first harmonic tone, but a few notes range up to 1.0 or 1.25 kilocycles due either to vertically longer “legs” at the ends of the inverted U, or to a lower-pitched start of the initial rise in irregular, initial, gradually rising notes.

Long Calls seem to occur when several Crimson-winged Woodpeckers are relatively near one another. In every case I heard Long Calls at times when two or more birds were calling (Pee-bee Calls). The Long Call functionally may contain more of an agonistic connotation, and be less of a localization note than is the Pee-bee Call, but this needs to be checked further.

LESSER YELLOWNAPED WOODPECKER

Picus chlorolophus

The Lesser Yellownappe is widespread, ranging from lowlands and hills of India and Ceylon to southern China and Sumatra. In Sundaland, where the closely related lowland *Picus puniceus*

occurs, it is restricted to highlands (above 1000 meters). Its habitats are most diverse in India, where it occupies hill forests, lowland evergreen forest, bamboo and other scrub, and open woodlands. Within India, however, it usually is the only species of *Picus* to occur and hence, perhaps, its diversity of habitats.

Foraging of *Picus chlorolophus* takes place on the trunks and major branches of trees, although it may occasionally descend into undergrowth shrubs. Pairs may forage near one another, usually not in the same tree, but most birds forage alone. One pair foraged for over one hour, keeping one to two trees apart, each feeding in three different trees. Their activities are confined to branches and trunks, and they usually move rapidly from a trunk up into the branches, then on to another tree. Their movements especially are rapid when they join foraging flocks of babblers (in Malayan highlands, species of *Garrulax*, *Stachyris*, *Alcippe*, *Heterophasia*, and drongos, *Dicrurus*). Strangely, six incidents of participation in mixed species foraging flocks all involved females. These moved rapidly, one covering four trees in seven minutes, moving from trunk to major branches. Their movements under these circumstances resemble those of *Picus mentalis*, that is, they move from site to site rapidly, often covering only a tiny area on one tree before proceeding to another. One female foraged briefly at one rotten area of one tree, flew to the branch of another where it foraged over 2 meters of distance, then dropped to the trunk of a third tree and progressed to the top, all within 10 minutes. Like *Picus puniceus*, however, Lesser Yellownapes occasionally spend a long period of time foraging at a broken area or rotten spot on a tree. One bird foraged at a rough, bulging area at the base of a down-dropping branch high in a tree for 12 minutes, shifting positions slightly every minute or so. In the foothills of northern India (West Bengal), where there occur various other species of *Picus*, as well as species of *Picoides*, *chlorolophus* forages entirely like *puniceus*, in the high branches and along the trunks of large trees.

Foraging modes include gleaning, tapping, probing, prying, and excavating. The latter occurs rarely, and even tapping is usually weak and quiet. When foraging at a broken place in the bark, periods may be spent motionless as insects (possibly ants) are drawn up by the tongue. When participating in foraging flocks,

taps are light and few, and no excavating seems to occur. Gleaning, tap-probing, and light pecking are the modes of foraging of most birds, most of the time. In India and Ceylon it forages to some extent on the ground (Jerdon, 1862; Henry, 1955), but I doubt that it does so elsewhere.

I found no nests, but Ali (1953) has discussed its nesting habits in India. Old nesting or roosting cavities of various sizes were observed within its range, but I did not see one of these woodpeckers enter a cavity.

Crest Raising was the only display that I observed. Like *Picus puniceus* it raises its crest when near other individuals of its species, and it also raises it when it flies from foraging site to foraging site.

I heard two vocalizations of *chlorolophus*. Stuart Baker (1927, p. 18) has described another, a "low chuckling sound, rapidly repeated" during an encounter between a male and a female. He mentioned that "I once watched a pair in the dusk alternate pursuing one another and uttering this ("chuckling") note until coition took place." The chuckling call most likely was a form of Wicka Call.

Several Long Calls heard in Malayan highlands contained eight to 10 slow, loud "kwee" notes, sounding very like *Picus puniceus*. However, I was unsuccessful in tape-recording this vocalization.

The commonest call of *Picus chlorolophus* is a wailing "pee-a," or "pee-ew," delivered precisely in the manner (head upraised, crest erected) of the Pee-bee Call of *Picus puniceus*, although structurally equivalent to the Peew Call of the latter. This Peew Call (fig. 221, n) of *Picus chlorolophus* is longer and slightly higher pitched (3.7 versus 3.2 kilocycles for peak of initial harmonic tone) than that call in *puniceus*; it also resembles the downward-dropping examples of the Kwee Call of *Picus miniaceus*, but is longer. Although the call varies somewhat, it usually has the form of an inverted U, but tapering downward (i.e., skewed toward the initial part of the note). All calls analyzed have the initial harmonic tone emphasized, the fundamental tone moderately loud, and other harmonic tones weak. Peew Call notes peak at 3.5 to 3.8 kilocycles, and usually last 0.46 to 0.55 second. Notes of one bird at Frazer's Hill, Malaya, were at the same pitch, but shorter (0.32 to 0.36 second in duration). The form of

the note varies from a slightly dropping, but almost horizontal shape with the sound of the dominant harmonic tone included within 0.4 kilocycle, through skewed notes rising more or less rapidly from 2.7 to 3.6 or so kilocycles, then dropping gradually to 2.5 kilocycles, to rapidly rising (1.8 to 2.3 kilocycles rising to 3.6 or 3.7 kilocycles), plateauing, then gradually falling notes that generally do not quite fall to the initial starting pitch. The last-mentioned notes were recorded only in India (West Bengal). All the notes exhibit a slight to strong "tailing" effect, trailing away from the highest point of the note, but this tail barely, if at all, extends beyond the note. One of four Indian examples has a peculiar terminal step at 3.0 kilocycles, following a gradual drop from 3.7 kilocycles. This vocalization seems to be a localization call, and perhaps it serves other functions as well.

CHECKER-THROATED WOODPECKER

Picus mentalis

This close relative of the Greater Yellownaped Woodpecker (*Picus flavinucha*) replaces that species in the Sundaland lowlands, extending north to Tenasserim and southern Thailand. It extends into higher hills in southern Malaya and Borneo, where the highland *flavinucha* is absent. Further, it is much less common in northern Malaya and northward than in southern Malaya. The Checker-throat is a bird of more dense primary forest, especially swampy portions and old, overgrown small cutover areas in the forest, where the understory is dense. I have found it, for example, wherever I have found the dense-forest-preferring *Dinopium rafflesii*, but it is more common and widespread than that species. It is found in dense forest edges, even rarely venturing slightly outside the forest to roost or even nest in a dead stub. Usually it is absent from secondary forest, but sporadically it is found in more dense, taller second-growth.

Foraging occurs at all levels in the forest, but by far the bulk of its time is spent in the lower canopy and upper understory, that is, between 3 and 15 meters above ground. In this setting it prefers the trunks of smaller trees (half-meter or less in diameter), low branches, saplings, and vines. Very agile and active, it moves, seemingly erratically about, foraging a short time in one site, fluttering to another, skipping several trees, then often veering back across its earlier path. Its

rapid movements "preadapt" it to participation in mixed species foraging flocks and indeed it is as frequent in such flocks as is *Meiglyptes tukki*. These foraging flocks contained various avian species especially of the families Sylviidae, Timaliidae, and Muscicapidae. Rarely do pairs forage together. When they do so, they may move together through the same tree, somewhat apart. Epiphyte-laden rotting stubs are favored joint foraging sites.

In keeping with the rapid movement of *Picus mentalis*, its foraging emphasizes gleaning and probing, with sporadic tapping and prying and rare excavating. Foraging birds on saplings and vines frequently hang, or even flutter to glean some insect. Their movements include backward hops, sideward and tangential bounds or fluttering short flights. Large areas are passed over, and thorough coverage is given only to small, circumscribed areas. However, the bird in its erratic movements may later return to other sites in a tree—sites passed by earlier. Rarely there is a repetitive tapping, or excavating, especially when not participating in a mixed foraging flock. *Picus mentalis* forages somewhat like *P. puniceus*; it is more active and it favors low rather than upper levels of the forest utilized most of the time by *puniceus*. Compared with *Picus miniaceus*, found at the same levels in the forest, *P. mentalis* is much more active and acrobatic, and it less frequently forages on larger tree trunks.

I noticed three instances of active association by Ferruginous Babblers (*Trichastoma bicolor*) with an individual of *Picus mentalis*. One case involved two babblers at Kuala Lompat, Pahang, and the others two, and two or three babblers at Pasoh, Negeri Sembilan. The babblers perched quietly one-half meter or so from the foraging woodpecker when it was still, then fluttered beside it to grasp flying insects startled as the woodpecker moved from site to site. Each incident lasted over 10 minutes, and one took place over 30 minutes, the babblers maintaining close contact with the Checker-throat. The instance involving three birds had one Ferruginous Babbler less closely following the woodpecker. This babbler perched 2 meters or so away from the woodpecker, it foraged more often on its own, and it disappeared and returned twice before flying away for good. There were no other birds nearby in these cases, that is, they did not involve mixed species flock foraging.

The Checker-throated Woodpecker is known to lay as many as three eggs in nests in Malaya during March and April (Chasen, 1939, p. 175), but I found no nests despite the sporadic drumming and Long Calls that I heard.

No displays were observed, other than conspicuous Crest Raising which is especially noticeable during flights between foraging sites. Pairs were seen infrequently, but males in such cases seemed to have more erect crests than did females.

Drumming bursts (fig. 20e) of this species were heard sporadically, but they infrequently were repeated, and thus I was able to record but five of them on tape. One case, a burst of 1.92 seconds duration actually contained an initial burst of 0.77 second followed by a pause, and then a burst of 1.0 second duration. Drumming bursts contained 17, 19, 28, and 30 beats, lasting respectively 0.77, 1.00, 1.22, and 1.42 second. Thus the rate of delivery ranges from 19 to 23 beats per second, considerably more rapid than in *Picus puniceus* (15.55 beats per second). At the time of my visit the drumming was irregular, and the function (possibly territoriality, attraction of a mate, localization) of this instrumentation is unclear.

Vocalizations of *Picus mentalis* include a single-note Pook Call, a single-note or series Keek Call, and a Long Call tentatively ascribed to this species. The Pook Call (fig. 22m) consists of a variable, vertical note with a peaked, inverted U-shaped, indeed almost V-shaped element having sound concentrated at the peak of the fundamental tone (2.5 to 3.1 kilocycles). The note rises sharply, and drops slightly more gradually, skewing the peak toward the initial phase. Beyond the peak extends a usually loud "tail" of sound, which may be as much as three times the duration of the peaked element. The peaked element is 0.04 to 0.07 second in duration; with the tail, the entire note varies from 0.11 to 0.20 second in duration. Distant calls show up on the sonagram only at the peak and the tail of the fundamental tone. Some of the calls, either clearer, or variant calls, show considerable complexity. Several notes show, for example, strong emphasis on the peak of the initial harmonic tone (5.5 kilocycles), on its rising portion both near its base (at 1.8 to 3.0 kilocycles) and near its peak (at 4.0 to 5.5 kilocycles), and on its falling portion (at 3.0 to 4.0 kilocycles), in addition to the very strong

fundamental from 1.0 to the peak at 2.8 or so kilocycles and the dropping portion of the fundamental tone from the peak to about 1.8 kilocycles. These variant calls also show a separate, peculiar element that gradually drops, following the peak of the fundamental tone, from about 2.5 to 1.8 kilocycles; this element follows the inverted-U element and is not a part of it. Two of these complex notes are 0.09 second in duration, with longer U-shaped notes than other Pook Calls that I recorded. Pook Calls sounding like "pook," "kyick," or "kwik" were uttered sporadically by foraging woodpeckers that I disturbed. I consider this call a low intensity aggressive and localization note. This call somewhat resembles the short Kip Call, and longer, dropping calls (Kew, Keep calls) of *Picus flavinucha*, the Pit Call of *Picus vittatus*, the Kjaeck Call of *Picus squamatus* and *Picus viridis*, and the Kjak Call of *Picus canus*, but it is higher pitched, with fewer overtones than most of these.

The Keek Call (fig. 22o) is a single note or (fig. 24a) series of up to eight notes uttered when the birds approach one another (pairs, or territorial males or females), but at a distance. The single Keek note also seems to indicate alarm. Notes vary in duration, single notes lasting as long as 0.37 second, and notes in series varying from 0.19 to 0.31 second. Basically, the note is a peaked, inverted U, extended terminally, often with a step in the gradual downslope. The peak itself bears a "tail" extending usually beyond the down-sloping, inverted U. Only the initial harmonic tone is emphasized in series of Keek notes, with a peak at 2.7 to 3.1 kilocycles, and all sound encompassed within 0.6 kilocycles below the peak of that tone. However, the longer, single Keek Call also emphasizes the fundamental tone (peak at about 1.7 kilocycles), although the initial harmonic tone (peak at 3.3 or 3.4 kilocycles) is dominant. The single notes also tend to have a weak tail compared with notes in series. Keek series of three to eight notes last 1.05 to 3.50 seconds, and notes are rendered at 2.27 to 2.81 notes per second. Initial notes in a series invariably are shorter than following notes, and they are structurally more peaked, like the Pook Call note. Indeed several of the recorded calls are preceded by a single Pook Call note (0.35 to 0.50 second before the Keek Call), and the initial note of the following Keek series clearly is somewhat intermediate between typical Pook and Keek notes. More horizontal

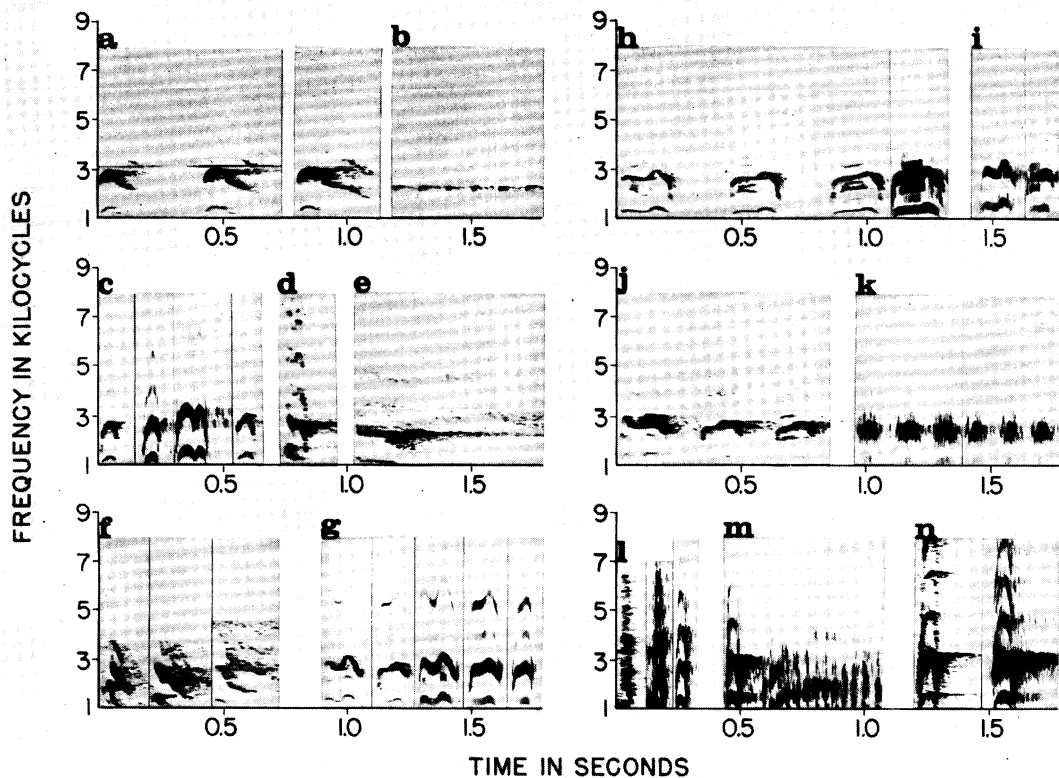


FIG. 24. Sound spectrograms of vocalizations of *Picus mentalis*, *P. flavinucha* and *P. vittatus*. a. First two notes, followed by last note of 5-note Keek Call of *Picus mentalis*, Malaya (disregard horizontal thin line, insect note, at 3 kc.). b. Six notes from center of Long Call of *P. mentalis*, Malaya. c. Keep Call of *Picus flavinucha* followed by same call, WB, then a double-noted Keep Call, WB, and finally a Keep Call tending toward a Kyew Call note, all from Thailand. d. Kyew Call of *P. flavinucha*, part of terminal tail excluded, Thailand. e. Kyaa Call of *P. flavinucha*, Thailand. f. Kyew Call of *P. flavinucha*, typical note followed by double-peaked note, then by long, dropping, horizontal variant, all from India. g. Separate notes from a 13-note Long Call of *P. flavinucha*, notes 1 and 6, followed, WB, by notes 1, 6, and 13, Thailand. h. First 3 notes of 5-note Kweep Call, third note followed by same note, WB, Thailand. i. Notes 1 and 11 of 22-note Long Call of *P. flavinucha*, Thailand. j. First 3 notes of 5-note fast Kweep Call, intermediate between that call and Long Call of *P. flavinucha* (see g and h; notes intermediate between Kweep Call and Long Call notes), Thailand. k. Parts of 29-note Long Call of *P. flavinucha*, notes 17 to 19 in sequence, then notes 27 to 29 in sequence, WB, Thailand. l. Kip Call of immature *P. vittatus*, short Kip Call followed by same call, WB, then a medium-length Kip Call, WB, Malaya. m. Kip Call of immature *P. vittatus*, long version, immediately preceding a Trill Call by same bird, WB, Malaya. n. Keep Call of *P. vittatus*, followed by a different Keep Call, WB, Malaya. All sonagrams are narrow band unless indicated wide band by WB.

Keek notes sound like "kyew" rather than "keek." These notes are very like the more dropping, variant Kyew Call notes and the more horizontal Kyaa Call notes of *Picus flavinucha*, given under similar circumstances.

A Long Call of *Picus mentalis* was heard on

several occasions, but I was able to record on tape only part of one call (fig. 24b). Notes of the call are like the terminal ("wi") notes of the Long Call of *Picus flavinucha*, but are lower pitched and more rapid; they also closely resemble the Long Call of *Picus vittatus*, but are

faster and somewhat higher pitched. The fundamental tone, which is emphasized to the virtual exclusion of overtones, is at 2.3 kilocycles. Each note consists solely of the peak portion of a rapid (0.035 second, excluding the "tailing" effect, which tends to connect the notes) inverted U, with virtually no variation in pitch. The 23 notes of one call, part of a 49-note call, covered a span of 2.35 seconds, giving a rate of 9.8 notes per second. I cannot offer more information about the call, although presumably it will be found to represent a territorial-localization vocalization.

GREATER YELLOWNAPED WOODPECKER

Picus flavinucha

The Greater Yellownaped Woodpecker ranges widely from the lower Himalayan slopes of India to mountainous South China and Hainan, and south to the mountains of Malaya and Sumatra. It usually is found in hilly or mountainous country, but it reaches the lowlands at the base of the Himalayas in West Bengal, and I have seen a family party nearly at sea level, in Prachuap, northern peninsular Thailand. Very vocal, it forages in pairs, or in family groups following nesting, the birds maintaining vocal contact, or even foraging in the same tree. Foraging sites are diverse, from tree bases (Jerdon, 1862, reported them on the ground occasionally in India, but if they do indeed come to the ground it must be rarely) to the highest branches. Very often they start low in the trees or in saplings, then proceed upward along the trunk and branches into the foliage. Most of their feeding takes place on the trunk and larger branches of small to large trees.

Foraging modes of *flavinucha* are diverse, including gleaning, probing, and tapping but little or no excavating. There is much probe-gleaning, that is probing into and scattering apart debris from leaf masses in crotches of trees, and in crevices. A male, then a pair, foraged one day in the smaller branches amid leaf clusters, hopping about crosswise, leaning, turning, and reaching to obtain small bluish fruits. A pair associating with a mixed species flock (babblers, bulbuls) in India fed for five minutes on lower trunks and (female) saplings, then both moved up into the branches and foraged there; in a total of 15 minutes they probed and gleaned, but only the male tapped (audibly) with the bill for more than a single peck. On other occasions

I watched individuals for as long as 25 minutes without hearing a tap, as they gleaned and probed in trees near me. A direct comparison with *Picus chlorolophus* was afforded by a female of that species flying into one tree, and a male *flavinucha* flying to an adjacent tree at about the same time. The female Lesser Yellownappe progressed rather slowly, stopping for longer periods, and pausing to glean or tap more frequently and confined its foraging to the trunk and major branches of its tree. The male Greater Yellownappe moved rapidly, often gleaning as it hopped upward; once in the upper branches it crisscrossed from one side of the tree to the other, then back again, even pausing momentarily on tiny branchlets. The latter bird completed its foraging before the other, and flew off.

An interesting episode attests to the diversity of feeding techniques and foods of this woodpecker. In India I spied a female foraging on the trunk of a tree. At a height of about 13 meters, it paused at an old (woodpecker) cavity, and to my surprise, it looked into the cavity several times. It then proceeded to reach in and pull out debris, apparently a nest. Leaves, twigs, and fibers were scattered about as it picked methodically, often half disappearing inside the cavity to seize more material. It appeared not to be feeding, but suddenly it flung out a body, apparently of a small bird or mammal, and abruptly fluttered down through the foliage after it. I glimpsed it carrying something farther into the forest, but could not determine what it was. About three minutes later the female returned to the cavity, but just as it inserted its head into the entrance, a male (possibly its mate) Greater Yellownappe landed below it on the trunk, and with only a flick of its crest (Crest Raising) almost instantly supplanted the female. The male tossed a few sticks and fibers out of the cavity, but quickly lost interest and flew away; the female, perched in a nearby tree, flew in the direction taken by the male. Among woodpeckers only *Picoides major* (fide D. Lack) and *Melanerpes erythrocephalus* (personal observ.) otherwise are known occasionally to kill and eat (baby) birds.

Nesting occurs from March to June in India, the birds utilizing a rotten tree in which to excavate a cavity between five and 20 feet of the ground (Stuart Baker, 1927). I found no nests, but during late March in Prachuap, Thailand, a family party contained at least three young birds

just able to forage entirely on their own. Nesting probably took place in late January–early February.

The only display that I observed was Crest Raising, in which the yellow crest is erected to varying degrees. This occurred in a male, which supplanted a female, and it was observed sporadically in apparently mated birds that foraged in the vicinity of one another. For example, after completing foraging in a tree, a male or female would fly to another tree, and land with a semi-erect crest if its presumed mate was foraging in a nearby tree. The crest was gradually depressed as the bird resumed feeding. Vocalizations (see below) often were uttered at such times, in conjunction with Crest Raising. Stuart Baker (1927, p. 24) observed courtship in a pair in India as follows: the male and female “continually chase one another with a little squeaking cry; finally . . . the female crouches close to the bark and the male then approaches her backwards, his head thrown right over his rump with beak held up and crest very widely expanded. After getting within a few inches of her he sidles across to the other side and repeats the same action, all the time the hen bird squeaking and shivering with excitement until, after a few repetitions of the male’s display, the two eventually meet.”

I saw a male drum twice in West Bengal, and I heard two or three other drumming bursts, but was unable to record this sound. Drumming of the Greater Yellownappe is wholly like that of *Picus mentalis*, that is, it consists of rather weak bursts of rapidly delivered beats.

The vocalizations of *Picus flavinucha* are varied, but basically involve modifications of a single element, except for the Kyaa Call. This element, an inverted U-shaped note, varied in pitch and more or less compounded into two such elements, thus is involved in most of this species’ repertoire. The basic element in unmodified form comprises the Keep Call, usually a single note of 0.05 to 0.07 second duration, emphasizing only the peak portion of the inverted U mainly in the initial harmonic tone (peak between 2.6 and 4.7 kilocycles, average of seven calls at 3.2 kilocycles), and to a lesser extent in the fundamental tone (peak at 1.3 to 1.7 kilocycles, one at 2.3 kilocycles). Often interspersed with Kyew Calls, or even uttered preceding Kyew Calls almost as a compound call, I heard this vocalization in Malaya, Thailand, and

India, usually when I disturbed a foraging bird or foraging pair. Several double Keep Calls (fig. 24c), that is, compound “keep” notes were heard and two recorded in Thailand. These calls contain an initial, slightly longer than normal keep note which adjoins a slightly shorter version of this note (calls 0.11 and 0.12 second in duration, with first and second notes respectively 0.07 and 0.04, and 0.08 and 0.04 second in duration). The call sounded like “keep-eeep” in the field. The Keep Call note of *Picus flavinucha* is similar to the following calls of other picids: the Keek Call of *Celeus brachyurus*, but lower and shorter; the Keek Call of *Picus vittatus*, but slightly lower in pitch, shorter, and without the “tail” common in this note of *vittatus*; longer Pit calls of *Picus vittatus*, but of lower pitch; and the Kjaeck Call of *Picus squamatus*, with which it is identical in form but longer. The double Keep note of *flavinucha* is lower in pitch but otherwise is identical to the double Keek note of *Picus vittatus*.

The Kyew Call (fig. 24d, f) is an apparently geographically variable call, usually repeated for a period of time, and emitted by a woodpecker sufficiently disturbed to pause in its foraging. Four or five calls may be uttered per minute, for up to four or five minutes. They are not delivered in series, but occasionally are preceded or followed within 0.1 to 0.2 second by one or two Keep Calls (fig. 24c; these are written as “keep,” “kup,” or “kip” in my notes). The Kyew Call basically is either a single peaked, inverted U-shaped (or Keep) note prolonged terminally by a rapid or gradual drop in pitch, heard only in India, or a compound or fused, double U-shaped note (like a double Keep note, but more tightly bound than in the double Keep Call), with the first peak higher pitched and the second peak followed by a strongly emphasized, more or less rapid drop in pitch, heard only in Thailand. A few of the Kyew Calls in India show a step in the latter part of the call, corresponding to the second peak of the Kyew Call heard in Thailand (fig. 24d). Both forms of the call emphasize the initial harmonic tone, and the pitch of the various tones is exactly within the range of that of the Keep Call. The Kyew Call differs from the Keep Call in its greater emphasis on harmonic tones, and of course in its greater length (0.09 to 0.18 and even in one case 0.21 second, averaging 0.102 second for seven calls in Thailand and 0.133 second for 11 calls in India, all exceeding the duration of Keep Calls).

Kyew Calls heard in India, as noted, lack a second peak or show only traces (at 2.3, 2.4 kilocycles, in initial harmonic tone in two of 11 examples) of it. They vary considerably in the portions emphasized, which may include predominantly the peak and drop of the initial harmonic tone (in two cases; fundamental tone and harmonics weaker, but receiving some emphasis), or, variably, only the dropping portion of the initial harmonic tone, or the peak of the fundamental tone and part of the dropping initial harmonic and even the next higher harmonic tone. In seven of 11 instances the peak of the initial harmonic tone is very weak, and not apparent on the sonagrams, and emphasis on dropping portions of the note gives a somewhat vertical aspect to it. Three variant Kyew Calls from India have a long, downsloping terminal portion making the note longer, 0.17 to 0.21 second in duration (versus 0.09 to 0.18 second for 11 other calls of Indian birds).

Kyew Calls from Thailand all have a prominent second peak, and an initial peak which mainly is weak prior to the descending portion in the initial harmonic tone, but usually is fully formed in the fundamental tone. In some calls there is a strong first peak in the fundamental tone, and a strong second peak in the initial harmonic tone, with the rest of these tones weaker, yielding a fully bisyllabic call (Ky-yew).

An intermediate Keep-Kyew (fig. 24c) note recorded in Thailand shows a step representing the first peak, and a prominent second peak (3.2 kilocycles, initial harmonic tone). It is of longer duration (0.08 kilocycles) than any Keep Call, and is shorter than any Kyew Call.

Kyew Calls in India are virtually identical to dropping Pook Calls of the related *Picus mentalis*. It is noteworthy that Kyew Calls of Thai and Malayan Greater Yellownapes differ more from Pook Calls of *mentalis* than do *flavinucha* Kyew Calls in India, for *mentalis* occurs adjacent to the range of *flavinucha* in Thailand and Malaya, and the differences may reflect past (or present) interactions of these species. The complex Kjaeck Call of *Picus viridis* shows some resemblance to Kyew Calls of *flavinucha* from Thailand and Malaya, but otherwise the Kyew Call is rather distinctive.

The Kyaa Call (fig. 24e), heard only a few times in India, is a wavering, horizontal note emphasizing the initial harmonic tone, and with sound tailing beyond the wavering portion for

more than the duration of the note. The fundamental tone at 1.2 to 1.4 kilocycles is weak, and harmonic tones other than the first are very weak. The dominant harmonic tone at 2.4 to 2.8 kilocycles essentially remains at that pitch with a wavering throughout the 0.18 to 0.22 second duration of the note. With the sound extending beyond it, the overall duration of the call (three examples) is 0.45 to 0.78 second. The only vocalization resembling it in related woodpeckers is the Kjaeck Call of *Picus canus*, the notes of which also waver; the latter complex call may have been derived from a note like the Kyaa Call. The function of the Kyaa Call is unknown.

The series calls of *Picus flavinucha* include the similar Kweep Call (fig. 24h), occasionally uttered as a single note, and the Long Call (fig. 24g, i, k). Notes of both calls essentially are connected, double Kweep Call notes, with emphasis on the second peak. Kweep Call notes differ from Long Call notes in their greater duration, with a plateau connecting the first and second peaks, in the prominence of a separate horizontal element, and in often having a "tail" of sound extending beyond the note. The Kweep Call series (fig. 24h) consists of generally fewer notes, uttered at a slower rate, and with moderate variation among notes within a call. Long Call notes (fig. 24g, k) show closely connected double peaks, or a rise to a single (second) peak with or without a step marking the first peak. A horizontal element is less prevalent and weaker when present. Notes vary greatly within every call, initial notes generally being longer and more complex, and terminal notes shorter, simpler, and more like Keep Call notes. Finally the generally longer call is uttered more rapidly, and at an increasing rate throughout.

Kweep Call notes vary only from 0.19 to 0.22 second in duration, which also is the maximum variation among notes within a single call. The initial note has a distinct first peak (fundamental tone at 1.4 to 1.5 kilocycles) in five of six series. Other notes, including the initial note of one series, and a single example of a one-note call, have no first peak or show only a very slight indication of a peak. The second peak in all notes is between 1.4 and 1.6 kilocycles in the fundamental tone, and it is followed by a sharp drop. The horizontal element consists of a short segment, most prominent at 2.2, 2.4, and 3.1 kilocycles, situated above and below the plateau connecting the two peaks in the dominant initial

harmonic tone. As many as six (possibly tones of a single element) of these horizontal segments are observed, but one call contains only the barest indication of two of them, and they are generally very weak or lacking in the initial note of a call. The single-note call differs not at all from notes in the series calls other than their initial note.

Five Kweep Call series containing five notes were uttered in 1.69 to 1.90 seconds, at a rate of 2.63 to 2.95 notes per second. A single six-note call was 2.25 seconds in duration (2.67 notes per second). In one call all notes were of the same duration, but in the others a slight shortening of notes (by 0.02 to 0.03 second) was observed between initial and terminal notes. Another call showed the fundamental and initial harmonic tones equal in intensity within its notes, whereas notes of the others were emphasized on the harmonic tone at 2.8 kilocycles (especially the second peak and its slight tail), and often the horizontal element at 2.2 kilocycles.

A five-note call was recorded that seems intermediate between the Kweep Call and the Long Call (fig. 24j). The call was 1.35 seconds in duration and notes thus were uttered at 3.63 per second. The individual notes resemble the Long Call notes in form (peaks close, no plateau between) but they are almost as long (duration 0.21 second for the initial note, and 0.17 second for the other four notes) as the Kweep Call notes. The horizontal element is represented by moderately emphasized segments at 2.2 and 2.5 kilocycles, and a weak segment at 3.1 kilocycles of the last three notes.

The Long Call (fig. 24g) is a series of variable length, speeding up in tempo especially toward the end. One rendering of the call in my field notes is "kwee-kwee-kwee-kwee-kwee-kwee-kwee-kwi-kwi-kwi-kwi-wi-wi-wi-wick." Nine examples contained 10 to 29 notes, with a duration of 2.02 to 4.75 seconds and a rate of 4.64 to 6.12 notes per second. Most calls speed up from between four and a half and five and a half, to six and a half to seven and a half notes per second between the initial second and the terminal second of the call. The second peak of the first harmonic tone is at 2.8 to 3.2 kilocycles for the initial notes and 2.3 to 2.8 kilocycles for terminal notes, and hence there is a slight drop in pitch (all but one call) through the call. Initial notes are 0.09 to 0.16 second in duration, and are either double-peaked (five of nine) or

have a strong, single (second) peak. One initial note is simple and appears almost like a Keep note. Another is peculiar in having a sharp vertical element rising above the peak at 2.9 kilocycles. These two peculiar initial notes are exceptional in the short duration (0.09 second) of the former, and the long duration (0.18 second) of the latter.

Most of the notes in a Long Call show a step up to the (second) peak; the first peak is absent but is marked by the initial horizontal area following the rise of a note. There is relatively little change throughout most of a given call. In longer calls there is only a slight drop in duration of notes for fully three-quarters of its length, but in shorter calls the middle notes may be halfway between the initial and terminal note in their duration. The longest call recorded, that containing 29 notes, is exceptional in its rapid shortening of (fig. 24k) notes such that notes even before the halfway point are more like the terminal than the initial note in duration. The initial harmonic tone is far stronger than the other tones, including the fundamental tone, in all notes. Terminal notes are simple, often consisting of only a curved or terminally rising peak, but in two cases there is a slight step. They average 0.069 second (0.05 to 0.09 second) in duration compared with an average of 0.134 second for the initial note and 0.109 second for the middle note of nine calls.

One short Long Call was recorded containing three notes delivered in 0.53 second (rate 5.66 notes per second). The call is peculiar in addition to its short duration in the prominence of the fundamental tone and harmonics other than the dominant initial one, and in a peculiar vertical element rising above the peak in the center of the initial note.

All the Kweep Calls and Long Calls reported herein were recorded in Prachuap, Thailand, late on the afternoon of two days in late March. The Kweep Calls were emitted by various individuals among a mated pair and three fledged young Greater Yellownapes. The Long Calls were uttered only by the two adults. The Kweep Call seems to be an alarm-agitation call, perhaps with localization overtones. I intruded upon the family party on both days, causing them to separate; the result was sporadic Kweep Calls from diverse directions, with one distant bird calling more persistently. At least some of the Long Calls were elicited by my presence, a



FIG. 25. Male Laced Green Woodpecker (*Picus vittatus*) in hand, Rantau Panjang, Malaya. Note pale lower bill.

challenge as it were, issued by the male, which approached my position several times to give a call or two. I should note that a favored tree standing apart from the forest (in a cleared field) bore a woodpecker cavity; I stood near this tree and flushed the male from it once, and it may be that this had been the nest tree, or was a "singing" perch of the male. On other occasions the male and female gave answering Long Calls, repeated several times, when they were far apart. The Long Call probably functions as a territorial proclamation call, and a localization call for members of a pair.

Kweep notes resemble the Keek Call of *Celeus brachyurus*, but are lower pitched. They also somewhat resemble Pee-bee Call notes of *Picus puniceus*, and are at the same pitch but more peaked. Long Call kweep notes resemble notes of the Kjaeck Call of *Picus viridis*, and if the overtones were reduced further they would resemble the Kly-kee calls of *Picus viridis*-*Picus canus*.

LACED GREEN WOODPECKER

Picus vittatus

Figures 25, 26

The Laced Green Woodpecker occupies mainly coastal areas of Malaya, Sumatra, and Java, and it extends north into coastal and inland regions of Thailand, Indochina, and Burma (this includes ranges of the *vittatus* and *viridanus* groups, which I am convinced are conspecific). Habitats occupied include mangroves, coastal coconut palm plantations and scrub, and areas of bamboo; in the north (*viridanus* group) it occupies hilly evergreen forest. Foraging occurs both in trees and on the ground. Arboreal foraging includes sites on the trunk and branches, and to a lesser extent in the foliage. In mangroves by far the greater part of arboreal foraging occurs low in the trees, probably correlated with frequent descent to the ground. Birds foraged for long periods on the ground in coastal Malaya,



FIG. 26. Female Laced Green Woodpecker (*Picus vittatus*) at nest, Rantau Panjang, Malaya. Note pale bill, unstreaked upper breast, and streaked abdomen.

then followed this with long bouts of arboreal foraging. In northern peninsular Thailand near Petburi, birds (possibly intermediate between *Picus vittatus connectans* and *Picus vittatus viridanus*) foraged almost entirely in abundant bamboo, but I saw one on the ground and several working in small trees. Feeding in palm trees takes place largely at the bases of fronds at the top of the trees. When on the ground they tend to feed near fallen branches and debris. Pairs often forage in neighboring trees, or sometimes in the same tree.

Foraging modes include tapping, scanning, and probing. Rough or broken places in trees, especially leaf scars of palms and sites of broken branches are favored, and much probing and "tonguing" of insects occurs at these sites. Laced Green Woodpeckers move rapidly up bamboo

shoots, pausing briefly at each node to scan its surface, and perhaps deliver a blow or two. At certain nodes they foraged for longer periods, using the tongue to extract insects, probably ants. A female chiseled a small hole in a sapling 5 centimeters in diameter, using single, hard blows, each followed by a pause; then it used its tongue to extricate insects. In the coastal palm scrub of Malaya where sympatric woodpeckers mainly include *Celeus brachyurus*, *Dinopium javanense*, and *Picus miniaceus*, *Picus vittatus* consistently was the only picid to tap audibly as it foraged. On the ground it hops clumsily, probing into the dirt or (mangroves) mud, scanning to the sides, swiping its bill at pieces of debris and rotted, fallen sticks, and probing into or tapping at fallen logs, especially where they touch the

ground. In tapping these woodpeckers often deliver the blows at an angle (laterally), rather than vertically.

By the end of March in the Petburi area of southwestern Thailand, a few young birds had fledged, but most adult birds still were occupied with nesting. One nest 3 meters up a stub near a house contained young birds on March 28, but I could not ascertain their number or age. In coastal Selangor (Rantau Panjang, near Klang) a pair incubated eggs or brooded very small young birds on April 3 to 5, a month after having excavated the (fig. 26) cavity 3 meters up a 5-meter tall, 13-centimeter thick palm stub beside a house and chicken coop. On April 24 the adults fed two young birds, flying well and perhaps five or six days after fledging, apparently from this nest. The young were fed on the ground, and as they perched in palm trees, but I could not see the actual feeding.

The only display I saw was incipient Swinging (body, head) by adults and young calling a low "wick-a-wick" as the adults approached to feed the young. Drumming (fig. 20d) of *vittatus* is a steady, even, low roll, very slightly faster (23 notes per second) than the longer-tending bursts of *Picus canus*. The drum is also virtually like that of *Picus mentalis*, but, again, a dozen or so bursts that I heard were shorter (possibly seasonal variation). Two recorded bursts lasting 0.87 and 0.60 second respectively contained 20 and 14 beats.

The Laced Green Woodpecker is very vocal, and has a variety of calls. These include the functionally and structurally related Keep and Kip calls, which are uttered singly, and calls in series, namely the Wicka Call, the Kjaeck Call, and the Pee or Long Call. Additionally an immature bird voiced many Trill Calls, which, however, may not be a part of the repertoire of the adult.

Keep Call notes are inverted U-shaped (occasionally more pointed, nearly an inverted V) notes 0.07 to 0.10 second in duration without the following tail of sound (fig. 24n) (0.30 to 0.43 second with the "tail"), and with primary emphasis on the initial harmonic tone, peaking at 3.2 to 3.5 kilocycles. The fundamental tone (peak at 1.6 to 1.7 kilocycles in 13 examples) may be moderately strong, but it is usually much weaker than the first harmonic tone, and occasionally it is surpassed in intensity by harmonic tones other than the dominant one. Several double Keep Calls (fig. 27a) were uttered by a

single immature bird. These contained a typical Keep note followed by a shorter note (0.06 second duration, two examples) pitched slightly higher, at 1.75 kilocycles (fundamental tone; dominant harmonic tone at 3.5 kilocycles). The barely separated notes of the double Keep Calls have moderately strong fundamental tone peaks. These calls lasted 0.16 and 0.14 second (with "tail," duration 0.30 second for both). Shorter Keep Call notes are very like the Keek Call of *Picus flavinucha*, and the double Keep Call of *vittatus* is like that of *flavinucha* except that the individual notes are more separate, and they are slightly longer and higher pitched.

Kip Calls are essentially short, low-pitched Keep Calls, and they vary from long Kip notes (fig. 24m) to moderately long to short Kip notes (fig. 24l). The short Kip notes differ from the others in having a tendency to form a vertical bar of sound, and in considerable, diffuse, variously pitched sound introducing many but not all notes, and they may differ functionally from other Keep and Kip notes. The Kip Calls all were uttered by birds judged to be immature, and they may to some extent reflect ontogenetic development of the Keep Call from begging calls of nestlings through an intermediate Kip Call stage. However, all three types of Kip Call were emitted by a single individual, so they do not represent completely a progressive development of the Keep Call through the three Kip Call stages. Three long Kip Calls with the fundamental peak at 1.6 to 1.7 kilocycles were shorter than any Keep Call, with durations of 0.04 to 0.06 second, or, including the "tail," 0.15 to 0.20 second. One of these, not differing from the other two, preceded a Trill Call.

Moderately long Kip Calls (fig. 24m) closely resemble the long Kip notes and Keep Call notes in form, but are shorter (0.04 second without, and 0.07 to 0.10 second duration with tail) and lower pitched (fundamental peaks at 1.4 to 1.6 kilocycles). Tones other than their dominant harmonic tone receive emphasis only at their peaks. One such call of six, given in flight, had equally strong fundamental, initial harmonic and next harmonic peaks formed as flat peaks, that is, with an initial vertical rise to the peak followed by a perpendicular shift to the horizontal plane. Another of these notes is double-peaked, with a slight step to a second peak (within the note, that is, not a double note). Two of these notes preceded Trill Calls.

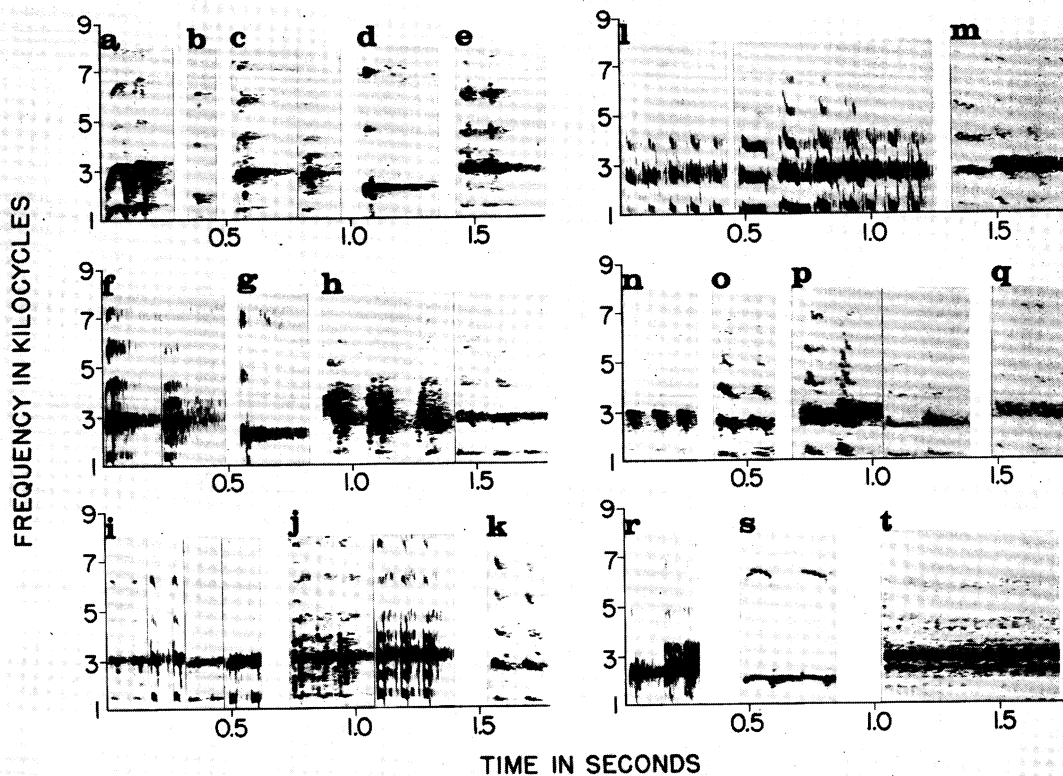


FIG. 27. Sound spectrograms of vocalizations of *Picus vittatus*, *P. canus*, *Dinopium javanense*, and *Chrysocolaptes lucidus*. a. Double Keep Call of immature *Picus vittatus*, Malaya. b. Kik Call of *P. canus*, Austria. c. Kow Call of *Dinopium javanense*, followed by variant having extra tones, Malaya. d. Keek Call of *Chrysocolaptes lucidus*, Thailand. e. Double Kow Call of *Dinopium javanense*, Malaya. f. As c, but WB. g. As d, but WB. h. Kjaeck Call of *P. vittatus*, first a complete 3-note series, then 3 notes from middle of long series uttered by one of pair flying away, both Malaya. i. Notes in twos from Kowp Calls of *Dinopium javanense*, first two notes (notes 2, 3) of 5-note call, followed by same two notes, WB, then two notes (notes 2, 3) of 10-note call, followed by same two notes, WB, all Malaya. j. Complete Kowp Call of female *D. javanense*, leaving nest, followed by same call, WB (note extra tones in first note), Malaya. k. Kowk Call of *Chrysocolaptes lucidus*, notes 2 and 3 of 12-note call closely resembling Kowp notes of *D. javanense* (see i), Malaya. l. Two Kowk Calls uttered in sequence by *Chrysocolaptes lucidus*, first a 5-note call, then a 7-note call (notice variation in duration, peaks, of the various notes), WB, Thailand. m. Kow Call of *C. lucidus* ("ke-dew-kow," 3 notes, notice variation), Thailand. n. Kowk-like Rattle Call of *C. lucidus*, notes 10 to 12 of 16-note call in flight, in response to call of another bird, Thailand. o. Kowk Call of *C. lucidus*, notes 1 and 2 of 9-note call, Malaya. p. Kow Call of *C. lucidus*, full 2-note call followed by another 2-note call, the first and third of a series of 3 such calls (note variation in peaks and tones represented among notes of the 2 calls), India. q. Kowk Call of *C. lucidus*, notes 4 and 5 of 12-note call showing double-peaked notes, Thailand. r. Keek note initiating a 7-note Rattle Call (first 2 notes are shown) of *C. lucidus*, WB, Thailand. s. Kjack Call, notes 1 and 2 of 8-note call of *Picus canus*, Germany (prepared from copy tape provided by D. Blume). t. Rattle Call of *Dinopium javanense*, initial 14 notes of 28-note call, Malaya. All sonagrams are narrow band unless indicated wide band by WB. To save space "tails" ending some of notes are partly excluded from figures. See text.

Short Kip Calls (fig. 24l) are still lower pitched (fundamental peak at 1.2 to 1.6 kilocycles in 17 examples and shorter 0.025 to 0.035 second duration; with tail, 0.05 to 0.14 second duration). These rapid notes assume a vertical aspect, with sound connecting the peaks in many examples; also, the peaks tend to be emphasized excluding their legs, giving the effect in a sonagram of a vertical blurred line of spots. Tones other than the dominant harmonic tone receive rather more emphasis than in longer Kip notes, such that the fundamental tone or even the peak of one of the higher pitched harmonic tones is prominent. As noted above there often is an intense, diffusely pitched sound concentrated between 1 and 3 kilocycles preceding the call for 0.04 to 0.08 second. Some of these notes are mixed with longer Kip Calls, and with a Wicka Call, and short Kip Calls also are uttered as birds take flight.

The Keep-Kip Call is used in situations of stress, as when an intruder disrupts foraging. It can be persistent, as in adult birds about a nest, or in one case when I interrupted a foraging immature bird. The Kip Call may function as a location call in young birds, allowing adults to find them. I consider this call complex to be a low-intensity agonistic vocalization. Long Kip Calls exactly resemble the Kjaeck Call of *Picus squamatus*, whereas short Kip Calls resemble the Kik Call of *Picus canus*, but are lower in pitch.

A trill, tentatively designated the Trill Call (fig. 24m), was emitted sporadically by an otherwise Kip-calling, foraging, young Laced Green Woodpecker. Of eight examples, two are preceded by a short Kip Call (0.15, 0.25 second prior to trill), one by a moderately long Kip Call (by 0.08 second), and one was preceded by a Wicka Call. The trills contained eight to 20 notes given at 25.6 to 28.0 notes per second for a duration of from 0.28 to 0.73 second. Notes consist of variably pitched peaks, inverted, V-shaped without "legs" (chevron-shaped), with the sound concentrated at one or two pitches. A definite characteristic of this call is its wavering frequency, usually with one or two each of high and low points per call (this wavering reminds one of the wavering rattle of *Chrysocolaptes lucidus* and *Blythipicus pyrrhotis*). I suspect that the low Trill Calls heard are leftover juvenile begging calls of *Picus vittatus*, and indeed, the bird that uttered the calls may have become

independent of its parents only a day or two before I encountered it.

Peculiar, low notes of two immature birds seemed to me in the field to represent the low, wicka-like calls ("ch-ch-ch") of two adults together, and of adults approaching and displaying aggressively at young birds ("wick, a-wick, a-wick, a-wick"). I consider these to constitute the Wicka Call (fig. 21l) of *Picus vittatus*, although further studies are needed to relate fully the three distinct notes associated herein. I designate these as A, B, and C Wicka Call notes. These are given either mixed or alone in series. As examples, I give the following sequences: (1) A, B, A, B, A, B; (2) A, B; (3) A, A, A, B, A, B, B-C (intermediate); (4) A, B, A, A; (5) C, C, C, C, Kip; (6) C, pause, A, B; (7) Kip, C, Kip; and (8) B, Trill. The "a-wick" or "ta-wah" notes I believe to form the Wicka Call equivalents of, say, *Celeus brachyurus*, that is, the A note is the vertical "ta" or "wi," usually followed by the B note, or "chew," or "tcha" note in *Celeus brachyurus*.

The A-type of Wicka note forms an abrupt vertical series of dots or vaguely chevron-shaped marks on a sonagram; the note is 0.015 to 0.03 second in duration. Peaks tend to be between 1.6 and 2.4 kilocycles, and above at 0.8 kilocycle intervals, but many are missing in the faint (most of the 11) examples at hand. The B note is slightly longer (0.025 to 0.035 second duration), and peaks at 0.7 to 1.0 kilocycles in the fundamental tone. Seven examples show various of these peaks; although most are faint, four of them show at least five peaks (e.g., at 0.9, 1.7, 2.6, 3.4, 4.3 kilocycles). The first and second presumed harmonic tones, and sometimes the fundamental tone and fourth harmonic tone are loudest. Basically, these are inverted, V-shaped notes, with emphasis on the dropping portion, often waveringly, forming the banded, vertical note characteristic of Wicka Call of diverse picids. The C note is a peculiar, down-tending, longer (0.035 to 0.05 second duration) note with a fundamental tone peaking at 1.0 to 1.2 kilocycles in five examples. The first and third harmonic tones are emphasized, and also the fundamental tone. In some instances only the descending portions receive emphasis. An intermediate B-C note, following an A-B (fig. 22d) Wicka Call, is 0.03 second in duration and has emphasized the harmonic tones at 1.8, 2.5, and 4.0 kilocycles. This note shows the banding of B

notes and the down-dropping element of the C note.

The B note of the Wicka of *Picus vittatus* is like the "chew" element of that call in *Celeus brachyurus*, but the note is shorter, lower pitched, and the bars are more horizontal (less dropping in pitch). The A and B notes of *vittatus* are like component notes of the Wicka of *Picus canus*, although the B note of *vittatus* is lower pitched and hence shows more tones. I am unable to find notes like the C note of *Picus vittatus* in the repertoires of other species. The Wicka Call basically is an agonistic vocalization. Its use by the immature bird that I encountered suggests that it was directed at me, as occasionally have Wicka Calls of *Colaptes auratus*.

The Kjaeck Call (fig. 27h) of the Laced Green Woodpecker is a complex, variable note. My examples of it are too few and too obscure to show all of its details, but it resembles the complex Kjack-Kjaeck calls of *Picus canus-viridis* in some aspects. I have examined sonagrams of a five-note, and a 24 (or more)-note Kjaeck Call. The notes are comprised of four main components, an initial Keek-like, inverted U-shaped element, a sharply inverted, V-shaped, high-pitched (fundamental peak at 3.8 to 4.0 kilocycles) element, a B-type Wicka notelike element, and a terminal diffuse burst of sound concentrated between 2.5 and 3.3 kilocycles. Notes of this call are 0.15 to 0.25 second in duration, including the "tail" of sound following the fourth element of the call. This initial Keek-like element is emphasized primarily at the peak of the initial harmonic tone (3.3 to 3.4 kilocycles). This element stands barely apart from the following elements, or is partly or even fully merged into the peaked element and the Wicka-like element. The second, sharply peaked element is emphasized particularly on its down-slope, forming a characteristic, conspicuous feature of the Kjaeck Call in sonagrams. The third, Wicka B-note element has a weak fundamental tone at 0.8 kilocycles, with emphasis on the harmonic tone at 1.5 to 1.7 kilocycles and various of the other tones (at least five harmonic tones show upon the sonagram). The final, diffuse element tapers off into a tail extending longer than the duration of the other elements taken together. These data are from five notes, two single-note calls, and a series of three notes uttered in 0.70 second. Another series of 24 notes lasting 3.8 seconds, with varying intensity such

that gaps exist in the fundamental tones, but not in the dominant initial harmonic tones, has the notes much compressed, and their elements somewhat obscured, although they generally are similar to those just described. The peak of the initial portion is emphasized, with a fundamental tone at 1.5 diminishing through the call to 1.4 kilocycles, and either simple, or with a double peak. The notes are close together such that the element of diffuse sound connects the notes at the pitch of the initial harmonic tone (3.0 kilocycles). These extremes of the Kjaeck Call show close resemblance to the variant types of the complex Kjaeck Call of *Picus viridis*, and, to a lesser extent, to the Kjack Call of *Picus canus*. This variable call is used as a flight call, apparently aggressively as the bird flees from an intruder, and it often is uttered by two birds together as a vocal agonistic display upon establishing contact when one flies to a perch near the other, or as an alarm as the two fly at the approach of an intruder. Also it may serve as a location call when paired birds fly in different directions.

The Long Call or Pee Call (fig. 28i) is a simple series of inverted U-shaped notes, emphasized only at the peak of the fundamental tone (1.2 kilocycles, all notes of five calls). In two calls there is some sound concentrated on the lower legs of the initial harmonic tone, but other than that and the peak of the fundamental tone, the only sound shown on sonagrams is a weak "tail" following the peak of each note. Notes last 0.03 to 0.05 second, separated from one another by 0.07 to 0.12 second generally, except that there is greater spacing of notes toward the end of the calls, and, especially, the last note is 0.13 to 0.17 second after the penultimate note. The five calls contain eight to 21 notes, with durations of 1.18 to 3.20 seconds, and average rates of 6.56 to 7.32 notes per second. The longest call shows a rate of six and three-quarter notes per second in the middle of the call, seven and one-half notes in the initial second, and seven notes in the terminal second. In comparison, *Picus canus* utters a generally shorter Pee or Kee Call at a higher pitch (1.6 kilocycles); the notes are longer (0.07 to 0.08 second) and more slowly (5.8 per second) rendered. *Picus viridis* has a similar call, usually with even longer, higher pitched, and more slowly uttered notes. Other species of *Picus* have such calls with notes higher pitched, and generally longer, and *Celeus* resembles these. The Long

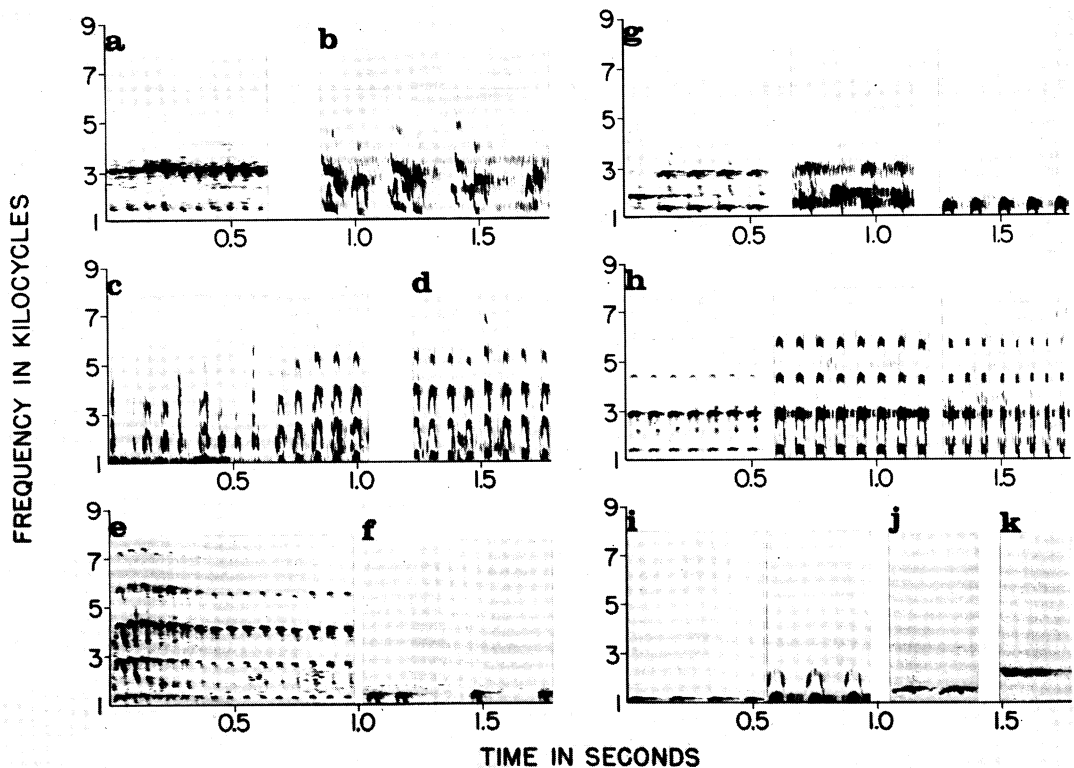


FIG. 28. Sound spectrograms of vocalizations of *Dinopium javanense*, *D. rafflesii*, *Chrysocolaptes lucidus*, and three species of *Picus*. a. Intermediate Kowp-Rattle call notes, last 8 notes of long Rattle Call series of *Dinopium javanense*, Malaya. b. Part of 4-second Wicka Call of two *D. javanense* together (shown are 6 vertical, banded, inverted U-shaped notes, 1 dropping note in the right centre, and at least 5 inverted V-shaped notes), WB, Malaya. c. Interspersed Wicka Call (vertical, banded notes at left) and Rattle Call notes followed by beginning of a Rattle Call (5 notes at right) of *Chrysocolaptes lucidus*, adult male and juvenile male together, WB, Malaya. d. Rattle Call of *C. lucidus*, 8 notes from middle of long Rattle Call, WB, Malaya. e. Beginning of a long Rattle Call of *C. lucidus* (notice wavering pitch and uneven tempo and loudness of notes), Malaya. f. Slow Long Call of *Dinopium rafflesii*, last 4 notes of 34-note call showing delay in delivery of last 2 notes, Malaya. g. Slow Long Calls of *D. rafflesii*, Malaya, first notes 12 to 16 of a 23-note call (notice variant note 12), followed by notes 4 to 7 of another 23-note call, WB (notice variant note 5), and then notes 9 to 13 of an 18-note call, WB. h. Fast Long Calls of *D. rafflesii*, Malaya, first notes 13 to 19 of a 32-note call, then notes 11 to 18 followed by notes 27 to 34 (note lessened duration of notes 27 to 34) of a 34-note call, WB. i. Long Call of *Picus vittatus*, notes 15 to 18 of a 21-note call, narrow band, followed by notes 13 to 15 of same call, WB, Thailand. j. Long Call of *P. canus*, notes 2 and 3 of 5-note call, Austria. k. One note of a slow Long Call of *P. viridis*, Austria. All calls are narrow band unless indicated wide band by WB. See text.

Call of South American *Colaptes punctigula* is convergently similar to that of *Picus vittatus*. Like these other Long Calls the Pee Call of *Picus vittatus* seems to be a territorial song or proclamation, and it perhaps serves also as a localization note.

SCALY-BELLIED GREEN WOODPECKER

Picus squamatus

This woodpecker is restricted to the Himalayan slopes of India from Kashmir to Sikkim, and

the mountains of Afghanistan. I glimpsed a single individual at the edge of montane forest at an elevation of 3700 meters west of Darjeeling, West Bengal, in early May. The bird foraged on the ground beside the trees. After it disappeared upslope, I heard a burst of bisyllabic calls, "Klee-wi, Klee-wi" which seems to have been an alarm or aggressive call ("Klee-gu" or "peacock" referred to by Whistler, 1928, p. 215). This woodpecker is known to feed partly on the ground and to drum at certain times (Ali, 1949).

The only other information I can contribute concerning this woodpecker is a brief analysis of a vocalization recorded in Nepal by G. Thielke, a copy of which was made available to me for study by D. Blume of Gladenbach, Germany. Blume designated (in lett.) this call as a "Kjaeck" Call, but sonagrams of three examples show this single-noted call to be structurally similar not to the Kjaeck Call of *Picus viridis* and Kjack Call of *Picus canus*, but rather to the Keep Call of *Picus vittatus*, and Keek Calls of other species of *Picus*. This is probably the "kjupk" note mentioned by Whistler (1928, p. 215). The note is a simple, inverted, U-shaped note, strongest at the peak of the initial harmonic tone (2.8 to 2.9 kilocycles), and having a strong "tail" extending well beyond the latter peak. The three notes are 0.06 to 0.07 second in duration, extending to a total duration of 0.22 to 0.25 second with the "tail." The fundamental tone (peak at 1.4 to 1.5 kilocycles) and the (possibly second) harmonic tone peaking at 4.3 kilocycles are moderately strong, whereas other harmonics (peaks at 5.6, 7.0 kilocycles) are weaker. Presumably this is a low-intensity agonistic vocalization, but further information is needed.

GRAY-HEADED WOODPECKER

Picus canus

The most widespread species of its genus, the Gray-headed Woodpecker ranges from west-central Europe to eastern Siberia, China, northern India, and peninsular Thailand, with isolated races in Taiwan and in the mountains of Malaya and Sumatra. My observations of this species in Asia occurred only in northern peninsular Thailand (Prachuap, Petburi, Ratburi), but I also studied it in Austria during July and August, 1970. Its habitats are as varied as its wide range would suggest, for it occurs in various

types of forests, in second-growth woodlands, and in scattered woods interspersed in more or less open country. In Thailand it was common in seasonally dry (monsoonal) lowland second growth, especially where the trees are dense, but there is some open ground between them; I also found it there in bamboo groves intermixed with second-growth. It does not seem to utilize open country except immediately adjacent to woodland.

The Gray-headed Woodpecker forages on the ground probably more frequently than any other Asian woodpecker. At least at some seasons and in some places most of its feeding may be on the ground, as in Thailand during late March. It also forages in trees by gleaning, probing, and tapping, much in the manner of *Picus vittatus*. Its arboreal foraging is accomplished mainly at broken places, crevices, and rotted areas, where it may perch quietly for long periods using its tongue and an occasional tapping to obtain insects (ants). Its terrestrial foraging involves the bird hopping about, probing into the soil, a shovel-like pushing or digging with the bill, and "tonguing" of ants from within the earth. The Gray-headed Woodpecker hops heavily, except when it pivots, in which case it takes a step or two (see Short, 1971c, p. 12). In a patch of dense but low (3-4 meter tall) small trees near Prachuap, Thailand, a male *Picus canus* foraged on the ground amid a mixed species foraging flock of tree-pies (*Crypsirina temia*) and babblers (including *Garrulax leucolophus*, *Garrulax pectoralis*), moving with the flock.

There is of course much information in the literature concerning the nesting, development of young, displays, and vocalizations of European *Picus canus* (Bussmann, 1944; Blume and Jung, 1959; Blume, 1962; Conrads and Herrmann, 1963; and Conrads, 1964). Except for summary statements, my comments are restricted to new information about this species.

At times of conflict the Gray-headed Woodpecker may Wing Flick opening and closing its wings rapidly. This seems to be a flight intention movement rather than an agonistic display. In Europe I have seen individuals duck under a branch while foraging when a calling Green Woodpecker (*Picus viridis*; the two closely related species hybridize rarely, Ruge, 1966) flew overhead, but I saw no interaction with other picids in Asia. It is sympatric with *Picus vittatus*, another close relative, in northern peninsular Thailand;

compared with *vittatus*, it is quieter and less conspicuous, and it forages more often on the ground.

The following are the vocalizations known for *Picus canus*, as described by Conrads and Herrmann (1963) unless otherwise indicated: 1) the Kü Call, diverse in function, and given in series of up to 10 notes; 2) the Kjack Call, a vocal threat display; 3) the Djök Call, a "pairing" call; 4) a Wicka Call (called a close threat call by Conrads and Herrmann, 1962, as "die-die-die" or "wi-wi-wi," but see Conrads, 1964; 5) a so-called warning call, Kük; 6) an anger-alarm call, quäquäquä; and three begging or other calls of young birds. In Thailand I heard both a Kü Call, which I term the Kee Call (Long Call), and the Kük Call, which I term the Kik Call; however neither was recorded. I discuss some vocalizations of *Picus canus* recorded in Austria in order to provide comparisons with *Picus vittatus* and other Asian species of *Picus*; I note that until now there has been no audio-spectrographic analysis of the vocalizations of *Picus canus*. Instrumental drumming and four vocalizations of *canus* are discussed at this time.

The Gray-headed Woodpecker, heard drumming in the Rathuri area of southwestern Thailand, drums in longer bursts than does *Picus vittatus*. Three drumming bursts from Europe (fig. 20f) are 1.14, 1.15, and 1.28 seconds in duration, and respectively contain 23, 23, and 26 beats (rate 20.0 to 20.3 beats per second). This drumming is slightly slower than that of *Picus vittatus* and *Picus mentalis*, and the bursts are, as noted above, longer than those of *vittatus*. The functions of drumming seem to be territorial proclamation and localization.

The Kik Call (fig. 27b) is a short, single, inverted U-shaped note expressing mild aggression or alarm. The fundamental peak at 2.0 to 2.2 kilocycles (six examples) is emphasized strongly, but the harmonic tones at about 4.2 and 6.3 kilocycles receive moderate emphasis. The legs of the inverted U are very weak, and the sound is concentrated within $\frac{1}{3}$ kilocycle below the peak. Some peaks show a step at 1.7 kilocycles in the dropping fundamental tone, and most "tail off" beyond the peak. The notes show a duration of 0.03 to 0.05 second without, and to 0.08 second with the tail. This call is higher pitched, has a less marked tail, and a more prominent fundamental peak than the very similar short Kip Call (fig. 24 l) of *Picus vittatus*.

A Wicka Call of an adult Gray-headed Woodpecker perched near another adult (male and adult unsexed), recorded in Austria, sounded like "chew, t-chew, t-chew." Analysis of sonagrams shows a short, higher pitched inverted V-shaped element following (or preceding) a lower pitched, longer, hence more (inverted) U-shaped element. The latter is the banded type-B element essentially identical to that found in the Wicka Call of *Picus vittatus*, and the shorter element is somewhat like the type-A note of that species. The B notes are 0.03 second in duration (fig. 21m) with a fundamental peak at 1.1 to 1.2 kilocycles, and a total of five or six visible peaks including various harmonic tones. The lower pitched harmonic tones tend to be slightly stronger than the fundamental tone and the other harmonics. There is also a tendency for emphasis on the dropping portion of the note, and there is a step visible in sonagrams of two of four such notes, punctuating the down-trending bands of the note. This note is slightly higher in pitch than is the B note of *Picus vittatus*, but otherwise these are alike. The other note of the Wicka call is a high-pitched (fundamental peaks at 2.0 to 2.5 kilocycles), inverted V-shaped note followed by a "tail" in the loud fundamental tone. These notes are 0.015 to 0.02 second in duration, but they extend as long as 0.12 second with the "tail" of sound following the formed portion of the note. This note is much higher pitched than the type-A note of the Wicka Call of *Picus vittatus*. In the example studied the four B notes were spaced at 0.28, 0.30, and 0.32 second apart. The higher pitched, "A" notes were spaced at 0.30, 0.29, and 0.13 second, that is, three notes each followed by type-B note by about 0.04 second, and the fourth "A" note (same bird calling?) followed the preceding "A" note rather than a B note. In the examples of Wicka Calls of other species these notes are usually equally spaced in A-B-A-B sequences, but variations like that described here for *Picus canus* are known in *Picus vittatus* and in *Colaptes auratus* (unpublished sonagrams).

The Kjack Call, a series of variable notes is (fig. 27s) peculiar in the wavering pitch of its notes. Seven examples from Austria contain four to nine notes delivered in 1.10 to 2.28 seconds (3.33 to 4.54 notes per second). The notes are about equally spaced except that they are rendered more slowly at the end of the call (in six of seven calls). The notes are 0.10 to 0.21 second



FIG. 29. Nest (large tree, right foreground, near top of photograph) of Olive-backed Woodpecker (*Dinopium rafflesii*) at Pasoh, Negeri Sembilan, Malaya (see text).

in duration, and tend to be slightly shorter at the end of the call (in six of seven calls). Each note is an almost horizontal, wavering sound, showing a slight effect of a very broad, inverted U, but with emphasis only on the peak of the fundamental tone (at 1.7 to 2.2 kilocycles), and usually to a lesser extent on the harmonic tone at 4.8 to 6.4 kilocycles; other harmonic tones are

very weak. Notes of all calls show a steady drop in pitch of 0.1 to 0.4 kilocycle (fundamental tone) throughout the call. The notes are connected by a tail of sound extending fully between notes, giving a continuous sound (although the tails are unwavering, unlike the notes per se) at the pitch of the fundamental tone. The notes are, however, clearly demarcated by their distinct

(possibly second) harmonic tones, which have no tails. There is a faint vertical element marking the beginning and end of each note, visible in more than half the notes.

The Kjack Call does not closely resemble the Kjaeck Call of *Picus viridis*, which is lower pitched, shows some emphasis on all tones, has no wavering quality, and has stronger vertical components. It also is not particularly similar to the Kjaeck Call of *Picus vittatus*, although probably it is related to that call of these species. The Kjack Call appears to be a location call of both flying birds and birds at perches. It may function in other ways also.

The Kee or Long Call (fig. 28j) of *Picus canus* is a series of four to 10 notes serving location and territorial proclamation functions. Two Austrian calls of six and four notes respectively lasted 1.03 and 0.67 second (5.82 to 5.95 notes per second). Only the fundamental tone is emphasized, with a peak of the inverted U-shaped notes at 1.3 to 1.8 kilocycles. Most sound is within 0.25 kilocycle of 1.5 kilocycles. Notes diminish slightly in pitch through the call. The notes were shorter (0.06 to 0.09 second, plus "tail," totaling up to 0.15 second) in the six-note call, and longer (0.10 to 0.13 second, weak tail) in the four-note call. Thus, notes are longer, higher pitched, and more slowly delivered than in *Picus vittatus* (interestingly, the Kee Call notes of *Picus viridis* in the examples at hand continue this tendency, e.g., fig. 28k, being still longer, higher pitched, and more slowly uttered than those of *canus*).

OLIVE-BACKED WOODPECKER

Dinopium rafflesii

Figures 29–31

The Olive-backed Woodpecker inhabits swampy portions of lowland primary forests in Sundaland and north to peninsular Thailand and Tenasserim. Its preference for dense, wet portions of primary forest is responsible for this being one of the least known of Asian woodpeckers. I have not found the Olive-back in secondary forest, and only once did I observe it outside of primary forest, when a male assumed a perch in a dead stub 150 meters beyond the forest, in a freshly cut-over area. The birds range individually or much less commonly in pairs (out of sight of, but within hearing of one another) along the streamlets in the swampy

parts of forests, and out into surrounding fringes of drier forest. Their foraging occurs almost entirely at low levels from the bases of trees and saplings, and from fallen logs to the tops of lower understory saplings and about 8 meters up trees and stubs.

Much of the foraging of the Olive-back is by gleaning in the manner of the Common Golden-back, but the former frequently taps audibly and occasionally it gives a flurry of light taps. It moves rather slowly but more or less continuously with only brief pauses along the trunks and limbs of trees. A male tapped lightly on a rotten log that lay in water, then moved to the base of a small tree and foraged all the way around it before proceeding upward. It gleaned on the bark of the tree, but flew away when it was 3 meters up. Another male foraging in a small tree flew over 100 meters to another tree, and proceeded to glean along the middle branches at 5 to 10 meters above the wet ground. Both a male and a female sporadically ceased excavating a nesting cavity to pick up ants from the surface of the bark beside the cavity, and the male fed ants to the female (courtship feeding, see below) at the entrance to the cavity.

Nothing is known of the breeding habits of this woodpecker, and its nest has not previously been described. On March 11 I heard regular tapping from a live tree (species unknown) in a swampy patch of forest at Pasoh, Negeri Sembilan, Malaya. The tree, situated 10 meters from a well-used path, measured 25 centimeters in diameter at breast height (fig. 29). The Olive-backed Woodpecker, a female, worked at a circular opening $4\frac{1}{2}$ meters above the water, which was about 12 centimeters deep. The female excavated at the edges, hammering not very strongly, but effectively enough to loosen a piece of wood every minute or so. Once freed, the pieces were tugged out and tossed over the shoulder of the bird. All excavating was accomplished at the mouth of the hole, which presumably was not very deep at this time. The female worked from 10:30 to 11:08 A.M., when the male replaced her, uttering (one or both birds) a low call, displaying, and feeding her before she left (see below). I then watched the male (fig. 30) excavate exactly as had the female, for 14 minutes, when it suddenly flew off as if startled. I returned at 1:50 P.M. to find the female excavating; passing workers frightened her away at 2:18 P.M. I avoided the site much of



FIG. 30. Male Olive-backed Woodpecker (*Dinopium rafflesii*) at nest, Pasoh, Negeri Sembilan, Malaya.

the time because I did not want to hazard desertion of the cavity. On the morning of March 12 I checked for tapping between 7:00 and 9:12 A.M., but heard nothing. At 9:55 A.M., however, the male was excavating, delivering blows from a lateral position of the head to the edge of the cavity; it then leaned in and pulled out a piece, tossing it over his shoulder, as on the previous day. Occasionally he paused, then poked about either side of the nest entrance picking up and eating ants that seemed to be swarming up the tree. The male flew away at 10:55, and the female appeared at 11:05 A.M., to excavate for 20 minutes before passersby frightened her away.

I was unable to return to the nest until April 11, but at 10:40 A.M. of that day I found the female in the cavity, apparently incubating eggs. On the next day the female was in the nest at least between 1:00 and 3:40 P.M. I saw her

head in the entrance twice during that period, and she remained when I left. At 6:18 P.M. I was able to see the male in the cavity, and he remained there until dark. The female was seen in the nest entrance both in the morning and the afternoon of April 13, but I did not tarry to await developments. On April 14, while I watched for an hour (1:15 to 2:15 P.M.), the female was inside the nest cavity. Twice she tapped in a drumlike burst, very faintly (I was about 6 meters from the nest tree), from within the cavity, but whether or not this was a signal to the male is a moot point. Unfortunately, I could not await developments, but left the area that day, and Malaya shortly thereafter. Hence I do not know the fate of the nesting effort.

Displays observed include only Crest Raising, Bowing, Head Swinging, and Courtship Feeding. The male raised its crest when approaching the female at the nest described above. The



FIG. 31. Courtship feeding of female (right) by male (left) Olive-backed Woodpecker (*Dinopium rafflesii*) at nest, Pasoh, Negeri Sembilan, Malaya (see text).

other displays occurred in one encounter, that between the pair at the nest when the male replaced the female at 11:07–11:08 A.M. on March 11. The male flew in calling a low “ch-wee, ch-wee, ch-wee,” and landed at the nest entrance, supplanting the female. The female moved to one side as the male landed. His crest was erect as he faced the female, bowed his head low toward her, then swung his head slowly from side to side, repeating the “ch-wee” call. Then the male poked his bill into a column of ants progressing up the tree beside the nest cavity. After gleaning a number of ants he faced the female, called again, and with crest moderately raised, he leaned toward the female, inserted (fig. 31) his bill into hers, and presumably fed her the ants. The female then abruptly flew away, and the male began to excavate.

Otherwise only vocal displays were heard, for the birds foraged either alone, or, if together they were several trees apart, hence close contact ensued only occasionally at the nest.

I heard no drumming by this species, other than the instrumental tapping of incubating birds in the nest. I judge that this tapping, occurring as soft bursts of 10 to 12 beats, is an instrumental signal, or that such a signal occurs even if these instances were of “displacement” tapping, because of the regularity of the tapping. The tapping sounded very much like the soft, nest-site tapping of *Dinopium javanense*, which see.

Three vocalizations are all that I heard from the Olive-backed Woodpecker. The low “ch-wee” call described above, occurring in an encounter between members of a pair probably

is a form of Wicka Call. I was unable to obtain recordings of this vocalization.

The Long Call is a series of notes uttered either very or moderately rapidly. There are structural differences between the two versions, functional differences may obtain, and there is no overlap in tempo in the examples available for analysis, hence I treat them separately.

The Slow Long Call (fig. 28f, g) is a series of six to 34 notes (average 18.67 notes in 21 examples) delivered at a rate of 7.75 to 9.76 notes (average 8.79) per second, and lasting 0.68 to 4.10 seconds. Longer calls of this type commonly terminate in one to three separate, more slowly uttered notes. Ten calls with such endings have 16 to 34 notes and average 22.70 notes per call, whereas eight calls with no separate notes at the end have six to 18 notes and average 13.63 notes per call. Several calls show strong, lower pitched harmonic tones, but most emphasize only the fundamental tone. The pitch of the fundamental tone is at 1.3 to 1.6 kilocycles, and usually at 1.4 kilocycles. However, one call has peaks of its notes at 1.8 kilocycle, and two other calls have a few notes identical to these sprinkled among the normal, lower-pitched notes. Notes of diverse calls are 0.025 to 0.070 second in duration, with no consistent pattern of shortening or lengthening during a given call. Most of the calls show considerable, irregular variation in the duration of notes and some variation in their pitch. Those calls with appended separate notes have them following the call by 0.023 to 0.037 second, and if more than one note follows the call, there is a progressive slowing of the delivery. The calls are higher pitched and have more peaked notes delivered more rapidly than in the Long (Pee) Call of *Picus vittatus*. The rate of delivery in the Slow Long Call of *Dinopium rafflesii* is like that of the Long Call of *Meiglyptes tukki*, but the notes are lower pitched, longer, and asymmetrical (more emphasis on dropping portion of inverted U than on rising portion), and there is less emphasis on harmonic tones.

The Fast Long Call (fig. 28h) of *Dinopium rafflesii*, delivered at 12.31 to 14.02 notes per second (average 13.11 for 22 calls), contains 11 to 46 notes, and lasts from 0.93 to more than 3.0 seconds. Unlike the Slow Long Call there are no delayed, terminal notes, and several tones are emphasized, with the initial harmonic tone strongest in contrast to the dominant fundamental tone in the Slow Long Call. Also, the

Fast Long Call is very regular, with much less intra-call variation, and less variation among calls. Otherwise, the calls are similar, involving inverted U-shaped notes uttered at the same pitch in both.

The fundamental tone of the Fast Long Call, receiving slight to moderate emphasis, varies only between 1.4 and 1.5 kilocycles (in more than 400 notes). The strong initial harmonic tone is at 2.8 to 3.1 kilocycles, and there are weaker harmonic tones at 4.5 and 6.0 kilocycles. Individual notes vary up to 0.015 second in duration within a call, and from 0.015 to 0.04 second overall. In every case the notes gradually shorten throughout a call, with terminal notes averaging ($N=21$) 0.024 second in contrast to 0.035 second for initial notes. One call shows a slight increase in tempo of its notes, but the others do not. A few calls sporadically show slight enhanced spacing of notes at one or two points, but the gap in all (four) cases involves no more than a doubling of the normal spacing, e.g., from the normal 0.03 to 0.05 second between notes to 0.06 or 0.07 second between two notes.

There may be a functional difference between the Slow Long Call, uttered alternately by a vocally interacting pair, or only by one or another member of the pair, invariably in the general vicinity of the nest, and the more commonly heard Fast Long Call. The latter seems to be the usual territorial proclamation call. The Slow Long Call may be a more aggressive (possibly partly directed at me as an intruder) call, a localization-alarm call, or a reproductive-agonistic call.

COMMON GOLDENBACKED WOODPECKER

Dinopium javanense

Figures 32-34

The Common Goldenback is a widespread Asian woodpecker, ranging from India to southwestern China as far east as the Philippines and Java. Within this range it occupies lowlands generally, except that in Sundaland it seems restricted to coastal lowlands, that is, mangroves, palm scrub, and plantations, and cultivated areas generally. It is not a forest bird, but one of open woods, edges, cultivated trees, and parkland, being particularly common in such places as golf courses. I studied this species in



FIG. 32. Male Common Goldenbacked Woodpecker (*Dinopium javanense*) at nest in dead palm stub, Rantau Panjang, Malaya.

coastal Selangor, Malaya (palm plantations, mangroves), and in open dry forest in peninsular Thailand. Although it forages at all levels in trees, it usually is found low in trees and saplings. In palm trees, to which it seems attracted, it feeds on the trunk particularly about the frond scars, and at the top among and on the fronds. This Goldenback often flies long distances, apparently to favored foraging sites. Members of a pair usually forage near one another but on separate trees. When they are together on the same tree, an encounter invariably results in one bird leaving very shortly. This may be a reflection of the aggressiveness of this species, but more likely it reflects their rapid foraging habits—a single bird covers a tree too rapidly to allow foraging by two birds say in different parts of a single (palm or small) tree. In a few cases a

Goldenback moved onto the ground at the base of a tree, not to forage terrestrially, but to afford a platform for foraging on the tree base itself.

Foraging modes of *javanense* are somewhat diverse, but I saw no true “woodpecking” and indeed heard no noise made by foraging actions of this species. Smythies (1960, p. 334) alludes to their “hammering” in shedding bark of young trees, but this was not observed in Malaya or Thailand. Rather, the Common Goldenback is a gleaning, probing, lightly pecking species that moves usually rapidly from site to site on the trunk and main branches of trees. Its rapid movements are interrupted occasionally by long periods of motionlessness, as the birds perch without even calling. Although these woodpeckers peck sporadically, they make no noise in so doing. In mangroves I watched them forage



FIG. 33. Female Common Goldenbacked Woodpecker (*Dinopium javanense*) at nest in dead palm stub, Rantau Panjang, Malaya. Note face pattern.

over the trunk and branches to the tops of saplings and trees. On some days they jump off the trunk occasionally, apparently to hawk passing, flying insects. Movements are more rapid than those of the frequently sympatric *Picus vittatus*, with few stops to forage long in any one place. Much of their food seems to be ants taken as they move about the surface of trees. Foraging birds move irregularly, darting rapidly to one side or another, picking up an item (possibly an ant), backing down the trunk occasionally, or twisting the head to one side to glean an ant.

As the Common Goldenback climbs, its three toes are typically well spread apart. There is about a 50 degree angle between toes such that two toes are in the forward 180 degree arc, and the outer toe is about 30 degrees into the rear 180 degree arc. Birds at the nest cavity, or rest-

ing, maintain the toes closer together, with all three in the forward 180 degree arc. The flight of *Dinopium javanense* is characterized by a twisting and bending of the tail, seemingly to a degree beyond that necessitated by steering in flight.

One nest was in an 8 meter tall stub (figs. 32–34) of a coconut palm 18 centimeters in diameter. The cavity, 4 meters up the tree, was in an area devoid of bark. It was excavated some time prior to late February, when a Goldenback first was seen entering the future nest. Several visits in March indicated no activity at the site, but on April 4 both male and female separately visited the cavity, and entered it. Neither woodpecker remained inside for very long, but the male came to the entrance several times to scatter wood chips outside. Progress at nesting seemed very



FIG. 34. Female Common Goldenbacked Woodpecker (*Dinopium javanense*) at nest in dead palm stub, Rantau Panjang, Malaya. Note diagnostic (for field identification) streaking of crown.

slow, but on my return April 24 it became clear that incubation was occurring. I frightened the male from the cavity at 6:45 A.M. on that day. Within 10 minutes the female returned, and entered. At 8:00 A.M. the male flew in and replaced the female. The birds changed places punctually, on the hour for the remainder of the morning (female at 9:00 and 11:00, male at 10:00 A.M.). When I left near noon, the male was present in the presumed nest. The female was considerably more wary than the male, flying more readily when mildly disturbed, and taking much longer to enter the cavity than did the male. I was unable to pursue the observations further, for I left Malaya on April 26.

As noted previously, the sexes forage usually on separate trees, maintaining vocal and even visual contact. When, as occasionally happens,

one bird lands near the other, they move apart, usually to opposite sides of the tree. There is some "peeking" around the tree, accompanied by Crest Raising, but the birds move up the trunk on opposite sides of the tree. Usually one of them flies away before they reach the foliage or upper branches. Crest raising was observed in both sexes. A partly erect crest characterized the extremely wary female at the nest discussed above. Swinging of the body in a display, and a burst of "week-week" calls punctuated a brief encounter between two females, the only instance of an encounter between members of the same sex. One female then chased the other. During a copulation seen on April 4, the male had its crest raised as it mounted the female, which was perched crosswise on a large branch. No other displays were detected.

Drumming was not heard, except for low tapping at the nest by the male on April 24. On two separate occasions this bird gave three bursts of very low drums. Perched below the nest, it hunched, lowered its head as if selecting a spot, and then drummed a short, fast burst audible no more than 12 to 15 meters away. I was unable to record these drumming episodes. The male had its crest partly erect, and the drum appeared to be in response to my persistent presence near the nest. If not agonistic in function, the drum might be a signal to the mate, but its weak carrying power makes this seem unlikely; it is possible that these were displacement drummings.

No fewer than five calls were recorded and a sixth call, a high pitched "pee-pee-pee-pee-pee" was heard once but not recorded. This last call is of uncertain function. It was uttered by a male perched near its nest tree.

A Wicka Call (fig. 28b) four seconds in duration, uttered by one or both of a pair of birds, was recorded. Three kinds of notes are involved in the call, a vertical, inverted U, tending to drop, a slower dropping note, and a short, inverted V-shaped note. The vertical, inverted U-shaped notes were delivered regularly at 0.20 to 0.25 second intervals. These have a strong harmonic tone peaking at 3.0 kilocycles and a moderate, higher pitched harmonic tone (4.5 kilocycles), or a dominant initial harmonic tone at 3.0 kilocycles and a weak but equal fundamental tone at 1.5 kilocycles and next harmonic tone at 4.5 kilocycles. The note varies from 0.025 to 0.04 second in duration, and, with its slight emphasis on the downward, terminal portion, it is equivalent to the banded vertical element of Wicka Calls of other species, differing primarily in its weaker tones other than the dominant tone, and in its high pitch. The peculiar, dropping notes are irregular in occurrence in the call. They consist of a sharply dropping, stepped or unstepped element essentially lacking overtones, and with sound concentrated between 2.5 and 1.2 kilocycles. Two of these notes are double notes, one immediately following another. The notes are 0.03 to 0.04 second in duration. The inverted, V-shaped note is 0.025 second in duration and high in pitch (peak at 2.7 kilocycles). Harmonic tones are very weak in this call, but notes resemble those of species of *Picus*, *Celeus*, and some other woodpeckers.

The Kow Call consists of a single (fig. 27c, f)

or double (fig. 27e) note, structurally and probably functionally related to the Kowp Call and the Long Call (see below). I heard these "kow" notes infrequently, and I recorded only one burst of two double and then two single notes. These notes vary in that some show and others lack extra tones between the normal "fundamental" and "first harmonic" tones, and between the usual "first" and "second" harmonic tones. They also are unusual in having moderate to strong "tails" on all tones, and not just on the dominant tone. The fundamental tone, rather weak, is at 1.4 to 1.5 kilocycles. The dominant initial harmonic tone at 2.9 to 3.1 kilocycles has the strongest tail following its peak. Harmonics at 4.3 to 4.4 kilocycles and at 5.7 to 6.0 kilocycles are stronger than the fundamental tone and have moderate tails. The harmonic tone at 7.3 to 7.5 is equal in strength to the fundamental tone, or only slightly weaker than the latter. One of two single notes analyzed and the lead note of one of two double-noted calls show the additional overtones mentioned above. The single note with extra tones has one at 2.1 kilocycles, exactly between the usual fundamental and first harmonic tones, and slightly weaker than the fundamental tone, plus another at 3.6 kilocycles, midway between the usual first and second harmonic tones and stronger than all tones other than the dominant harmonic tone. The lead note of a double-noted call having extra tones shows the barest indication of an extra tone at 2.3 kilocycles and a moderately strong extra tone at 3.7 kilocycles, again midway between normal tones. The significance of this variation is not apparent, but the variation occurs also in the related Kowp Call. It may be that the actual fundamental tone and alternate harmonic tones are suppressed in some notes, but uttered in others. Notes of the Kow Call are 0.022 to 0.030 second in duration (six examples) without the terminal tail of sound. Inclusive of this tail, the single-noted calls are 0.32 and 0.27 second long. Double calls have the first and second notes identical in duration, separated by gaps of 0.06 to 0.07 second. Including the terminal tail, the double-noted calls are 0.43 and 0.47 second in duration. The Kow Call is lower pitched, more variable in the expression of its tones, and has a stronger tail, but otherwise it resembles the call note of *Blythipicus rubiginosus*.

The Kowp Call (fig. 27i, j), mainly or entirely given while the bird is in flight or as it takes off

or lands, is a complex, variable call the notes of which are modified or unmodified Kow Call notes. It is likely that the Kow Call functions at least partly as a low to moderate intensity alarm note. The Kowp Call thus may be partly a more intense alarm (bird caused to fly) call, which also serves other functions. One such additional function appears to be that of maintaining contact between flying members of a pair, given the facts that paired birds associate closely most of the time, and that they may fly long distances from one foraging site to another. These functional differences probably are reflected in the variation in the Kowp Call, but further studies are necessary to clarify this problem.

Nine Kowp Calls contained three to nine notes delivered in 0.21 to 0.83 second (excluding the terminal tail of sound, which adds from 20 percent of a longer call and up to 100 percent to a shorter call) at a rate of approximately 10 to 13 notes per second. Notes of these calls have a presumed fundamental tone peaking at 1.4 to 1.6 kilocycles, a dominant presumed initial harmonic tone at 2.8 to 3.2 kilocycles, and other weak harmonic tones (at 4.6, 6.0 kilocycles). However, just as in variants of the Kow Call, a few, usually initial notes of a call (in two calls) show additional harmonic tones exactly midway between the usual tones. These additional tones appear at 2.3 or 2.4 and at 3.7 or 3.8 kilocycles, with the apparent fundamental tone at 1.4 to 1.6 kilocycles actually representing an initial harmonic tone. This variation requires additional investigation (see below). Most of these calls are connected at the dominant 2.8 to 3.2 kilocycle tone by a tail of sound continuous through the call, but notes of two calls are completely separated by virtue of a weaker tail. Except for the additional tones in a few initial and other notes, the notes of a given call are alike in form, but terminal notes are slightly longer (0.025 to 0.03 second) than are initial notes (0.02 second in duration).

Two Kowp Calls have notes structurally intermediate (fig. 28a) between Kowp Call notes and Rattle Call (see below) notes. The calls are long (nine, 11 notes), and the notes are uttered more rapidly than in the Kowp Call and more slowly than in the Rattle Call (notes rendered at 15.0 and 17.5 notes per second, respectively, in the nine-note call lasting 0.60 second, and in the 11-note call lasting 0.63 second). Harmonic tones are suppressed in those calls, with the only

prominent tones at 1.6 kilocycles (possibly fundamental tone) and especially at 3.2 kilocycles. The strong tail of sound at 3.2 kilocycles connects the notes and extends beyond each call for fully one-third of its length. Unlike normal Kowp Calls and also unlike Rattle Calls, the terminal notes of these two intermediate calls are shorter than initial notes of the calls.

Four examples of more complex Kowp Calls (fig. 27j) differ from the normal calls in their strong emphasis on vertical elements (the rising and falling "legs" of the inverted, U-shaped notes), and in the greater prominence of an additional set of harmonic tones. These calls include a burst of three calls, progressively a three-noted, a five-noted, and a four-noted call, emitted by a female flushed from a nest, and a three-noted, apparently suspended or abruptly terminated call uttered in the same area perhaps by that same bird. The calls are 0.20 to 0.36 second in duration, without the terminal tail of sound that doubles the length of the three-noted calls, and their tempo is like that of normal Kowp Calls. The notes are either equal in duration throughout the call, or the terminal notes are shorter. As in the usual Kowp Calls, emphasis is on the dominant tone at 3.1 or 3.2 kilocycles, but its legs, especially the terminal dropping leg, are emphasized even down to the next lower tone. Three of the four calls show additional tones throughout; the abrupt three-noted call does not, although it has strong vertical elements (its peaks are at about 1.6, 3.2, 4.8, and 6.4 kilocycles, with the second tone dominant and the first moderate in intensity). The additional tones are strongest in initial notes, and they tend to fade in terminal notes. One initial note clearly shows a faint fundamental tone at 0.8 kilocycle, and further tones at 1.6 (moderate), 2.3, 3.1 (dominant tone), 4.0, 4.8 (last two moderate), 5.6, 6.3, 7.0, and 7.8 kilocycles; the terminal note of this three-noted call shows only tones at 1.6, 3.3, 4.7, 6.3, and 7.8 kilocycles. The other two calls show nine and six tones initially, diminishing (by suppression of various of the additional overtones) terminally to six and five tones, respectively. Whereas the Kowp Call usually sounds like "kowp-owp-owp-owp" (four notes), this version of the call sounds like "ka-da-da-dit," that is, something like the sound of the Rattle Call. Possibly there is more alarm and aggression embodied in the function of this variant type of

Kowp Call compared with more of a location function in the other Kowp Calls.

The Rattle Call (fig. 27t) is a long, fast series of 17 to 57 or more notes lasting 0.72 to more than 2.56 seconds (rate 17.5 to 23.6 notes per second, averaging 20.7 for eight calls). The notes are vertical, peaked, inverted V- or U-shaped, with the sound either concentrated between 2.0 and 3.5 kilocycles, or with equal, moderately strong peaks at about 1.0, 2.0, and 3.0 kilocycles. In most cases the dominant tone is at 3.0 to 3.2 kilocycles, with a pronounced tailing effect such that individual peaks are concealed, thus forming a band of sound. In one call there is a rather abrupt shift from notes with peaks at 1.5 and 3.1 kilocycles, equally emphasized (forming two sound bands), to notes with peaks at 1.1, 2.2, 3.2, and 4.1 kilocycles, the dominant peak being at 3.2 kilocycles, but with moderately strong peaks at 1.1 and 2.2 kilocycles (thus forming three bands of sound). This shift occurs at the tenth note of the 50-note call. The initial notes of this call resemble, but are shorter than Kowp Call notes. Indeed, a Kowp Call immediately precedes (by 0.15 second) this Rattle Call, and its tail of sound connects the two calls precisely at 3.1 kilocycles.

The Rattle Call notes are 0.015 to 0.025 second in duration. In some calls there is no variation in duration of the notes, but where variation is regular, it is in the direction of a lengthening of notes (e.g., from 0.015 to 0.02 second) progressively through the call. These calls are uttered either in flight or while the bird is perched. It may serve as a location call, like the structurally related Kowp Call, but it probably also is an agonistic call used in territorial proclamation. It sounds like "dddddtdt" or "ka-di-di-di-di-di," as rendered in my notes.

A call rarely heard and of uncertain function is designated tentatively as the Long Call. It is a series of notes characterized by moderately strong, inverted U-shaped peaks at 3.3 or 3.4 kilocycles, a strong drop forming a vertical element at the end of each note, and a nearly equal peak at 1.6 to 1.8 kilocycles. All other tones are weak, and in this feature, in the lack of tailing of sound beyond the notes, and in their higher pitch, these calls differ from other vocalizations of *Dinopium javanense*. The two calls recorded are an abrupt four-noted call lasting 0.23 second and a 14-note call lasting 0.97

second. The latter changes in tempo from 12 to 16 notes per second from beginning to end. This rate is greater than that of usual Kowp Calls and less than that of Rattle Calls. The longer of the two calls was given by a male, apparently in response to a Long Call-calling *Celeus brachyurus* in an adjacent palm tree.

The Kow-Kowp-Rattle series of calls of *Dinopium javanense* closely resembles the Slow-Fast Long Call sequence of *Dinopium rafflesii*. The calls of the Common Goldenback generally are uttered more rapidly, and the Slow to Fast Long Call of *rafflesii* placed with the Rattle of *javanense* forms a series. The intermediate Kowp-Rattle Call, discussed above, has notes exactly like those fast, terminal notes of Fast Long Calls of *rafflesii*. The main difference, other than in tempo of the delivery, is in the more prominent tail effect in the calls of *Dinopium javanense*. It is not known whether *Dinopium rafflesii* utters single-noted calls like the Kow Call, but it probably does. I have no basis for comparing the Wicka Calls of the two species, since none were recorded of *rafflesii*. The tentatively designated Long Call is higher pitched, faster, and the notes are shorter than in the Slow Long Call of *Dinopium rafflesii*, but the notes are similar. In contrast, the Fast Long Call notes of *Dinopium rafflesii* are less peaked. Like Long Calls of *Dinopium rafflesii*, the Long Call of *Dinopium javanense* has little "tailing" beyond the notes. This call also resembles the Long Calls (Pee Call, etc.) of species of *Picus*, but is faster and the notes are shorter. Other similarities are noted with the higher pitched Long Call of *Meiglyptes tukki*, with the irregular, low-pitched, but fast Long Call of *Dryocopus javensis*, and with the Long Call of *Colaptes atricollis* (Short, 1972, fig. 21). The Kow Call (and thus the Kow-Kowp-Rattle sequence) is very like the Keep-Kip Call of *Picus vittatus*. The vertical emphasis in the Kowp Call is reminiscent of the Kjack-Kjaeck calls of species of *Picus*; indeed, all the calls of the two species of *Dinopium* resemble closely one or another call of species of *Picus* (see also *Chrysocolaptes lucidus*).

GREATER GOLDENBACKED WOODPECKER

Chrysocolaptes lucidus

The Greater Goldenbacked Woodpecker occupies the vast region from India and Ceylon to Indochina, Java, Borneo, and the Philippines.

Within this area it is largely sympatric with the Common Goldenback, from which it differs in having: ivory rather than dark eyes; a longer, heavier bill; double, dark moustache stripes rather than a single one; and a spotted rather than streaked crown (females). In Malaya, it seems darker above with a redder cast, and "dirtier," less clean-cut below than *D. javanense*. Otherwise, these species resemble one another in some of their habits (and vocalizations, see below), as well as in coloration.

The Greater Goldenback prefers large trees at the edges of primary forest, in secondary forest, riparian woods in open country or in dry forest, and, uncommonly, mangroves. In Malaya it occurs chiefly along the coast in larger trees backing the mangroves and to some extent in the mangroves themselves; rarely does it occur inland at the edges of primary forest. Foraging birds utilize trunks and branches of larger trees, including smaller branches as thin as 5 centimeters in diameter, and the trunks and major branches of smaller trees. They often feed in dead trees, or on dead stubs, and they may move long distances from one such site to another. In brushy country, as in coastal northern peninsular Thailand, the Greater Goldenback frequents scattered large trees along watercourses, and flies out from these to dead trees or large live trees standing apart along cultivated fields or amid shorter trees. Pairs usually forage in adjacent trees, or sometimes in the same tree; more rarely a single bird may feed alone. Family parties may maintain loose contact throughout the day vocally, then roost near one another at night.

Foraging birds generally move quite rapidly along a limb or up a trunk, tapping hard (audible for some distance) at regular, short intervals, and pausing for longer periods of excavating wherever a suitable site is found. On dead well-rotted trees, they actively strip off the bark, hitting laterally with the bill and scattering about large flakes of bark, and then probing or gleaning insects hidden beneath the bark. In recently dead branches this Goldenback excavates deeply and with vigor, spending much time (up to 35 minutes) on a single limb. It also probes, then usually taps strongly into epiphytes encountered along the branches. Most foraging is high up in trees, but the birds often begin foraging very low on a trunk, working their way rapidly up to higher strata. In contrast to the

Common Goldenback, the Greater Goldenback gleans very little, and it taps loudly and regularly, giving a clear indication of its presence. In seasonally dry woodlands of peninsular Thailand, where dry, rotten trees are common the Greater Goldenback outnumbers the Common Goldenback, and it occurs without the latter in scrubby second-growth as long as some large trees are present. However, in coastal west-central Malaya it is far outnumbered by the Common Goldenback. This may be a reflection of the paucity of larger trees in coastal Malaya, or the difference between the two regions may reflect some difference between the availability of ants at the surface of the bark (food of *D. javanense*) and the availability of subsurface insects (food of *Chrysocolaptes lucidus*).

Nesting takes place very early in the year, perhaps as early as December in coastal Malaya. I found an adult male *C. lucidus* feeding a fully grown, nearly independent young male at Kuala Selangor, coastal Malaya (in giant old trees on a lone hill above mangroves) in late February. Otherwise, Malayan birds seemed to be in pairs at that time. In Thailand and India (late March to May) I saw family parties including fully independent young, and pairs without young accompanying them. I am not aware of the duration of family parties beyond the nesting period, so I cannot hazard a guess as to the time of nesting of the birds I observed. The clutch size is reputed to be one (Robinson, 1928, p. 157; but two to six have been noted by Smythies, 1953, by Stuart Baker, 1927, and by others), but I have seen family parties of four birds, and one in Thailand contained five birds roosting together nightly. Reported to excavate nesting cavities that have an oval-shaped entrance, and to utilize the same tree for nesting year after year (Stuart Baker, 1927), the Greater Goldenback may use the same tree for several years, but clusters of holes (clearly indicating the presence of this bird in a region) probably are excavated in the following way. A nesting cavity is excavated in a suitable tree that may or may not have a cluster of several old holes. After the young are fledged, the birds return to the nesting tree, there to excavate, ultimately, separate roosting holes. Whether the two parents excavate new holes is not known. As many as five individual holes (fig. 35) were occupied nightly by two presumed adults and three presumed young birds in Thailand during late March. At another site in



FIG. 35. Series of 5 cavities of Greater Goldenbacked Woodpecker (*Chrysocolaptes lucidus*), used separately as roosting holes by a family of 5 birds on March 27.

Thailand three birds roosted, each in a separate hole, among a cluster of four holes. On May 3 near Sukna, West Bengal, I observed on a large tree trunk a male *C. lucidus* perched beside a hole about 1 meter above two females. The females, 15 centimeters apart and nearly horizontal to each other, were engaged in simultaneously excavating separate cavities. Each cavity had its entrance formed, and the birds were working inside. Presumably, at least one of the females was young, and, since an additional bird called nearby and the tree contained four holes, it is possible that both birds were immature. As many as seven holes could result from the nesting of a pair in one year if: a pair nested, the male roosted in the nest, and the female excavated a roosting cavity on the same trunk; the pair raised three young; and, the three young birds as well as both adults then excavated new roosting cavities in the same area of that trunk. I am not suggesting that all such clusters of holes

result from the effort of a single pair, that have nested in one particular year, but it is likely that many clusters do result in this way, and if the clutch size varies up to six eggs, all could do so. In the Sukna area I found four trees, each bearing a cluster of four to seven holes clearly made by the Greater Goldenback within an area of 300 by 150 meters. Additionally there were two trees with one such hole apiece; one of them was occupied by a nesting pair of parrots (*Psittacula alexandri*), suggesting that such lone holes are usurped by other animals before the woodpeckers can nest. The number of cavities attributable to this woodpecker within such a small area (certainly well within the territory of a single pair) suggests that the Greater Goldenback usually shifts its nesting activity from tree to tree yearly.

I observed very few displays of *C. lucidus*, mainly Crest Raising particularly of male birds when close to a female, and of the adult male

feeding and perched in proximity to the juvenile male mentioned above. Head-Swinging movements are detected when members of a pair are close together, for, like *Dinopium javanense*, the paired individuals usually maintain vocal contact and even visual contact, but when close they react usually by moving to opposite sides of the tree, holding their crests erect. In one case a female and male perched close together on a trunk, and the female proceeded very rapidly up the trunk about 10 centimeters ahead of the male. Their speed was greater than normal, and each delivered only a few sporadic peaks before they separated, each going up a separate branch, in the upper part of the tree. I saw several chases, and heard calls as noted below, but no details were forthcoming concerning displays because the birds flew too far off, or were obscured by vegetation.

The Greater Goldenbacked Woodpecker drums (fig. 36a) loudly in rapid bursts the beats of which increase in tempo but decrease in loudness as the burst progresses. Six episodes involved 32 to 49 beats lasting 1.15 to 2.20 second, but other bouts were heard that were shorter (as few as 12 or 13 beats). The rate of delivery averages about 25 beats per second (23.55 to 27.82 beats in six bursts), but varies from about 20 beats per second initially to 30 beats per second terminally. Although the beats generally weaken in intensity as they progress, there are also sporadic weak notes, or even breaks within a burst. A 49-beat drumming burst had a break of 0.12 second between beats 36 and 37. A 32-beat drumming bout had beats 24, 26, and 30 exceptionally weak. Drumming of *C. lucidus* is distinguished from that of other woodpeckers by its long duration, its fast tempo, and by the progressive weakening of its beats.

Diverse vocalizations have been recorded, including the Keek Call (fig. 27d, g, r) which is the infrequently rendered call note of the Greater Goldenback. It resembles the Kow Call of *Dinopium javanense*, but has a higher pitched fundamental tone which is dominant, in contrast to the lower-pitched but weak fundamental tone and dominant, higher, pitched initial harmonic tone of *javanense*. The fundamental tone peaks at 2.3 to 2.6 kilocycles, as an inverted, U-shaped note with a strong terminal dropping "leg" and an intense tail of sound. The harmonic tones at about 4.5, and about 6.8 kilocycles are strong, but only their peaks are

emphasized. The inverted U-shaped element is 0.025 to 0.035 second in duration, but with the intense tail these notes are 0.3 to 0.55 second in duration. Occasionally they are uttered in loose series about 0.95 second apart, but usually a sporadic call or two are all one hears. The Keek Call of *C. lucidus* resembles call notes of other species (*Blythipicus rubiginous*, *B. pyrrhotis*) than *D. javanense*, but its call is distinct from that of all these species by virtue of its strong (dominant) and high pitched fundamental tone. Mild aggression and alarm seem indicated by this call, given when the birds are disturbed but do not fly.

Another single note, recorded once, is a "chit" call following a Rattle Call, and identical to (Thai) Rattle Call notes in its form. The note is an inverted, U-shaped note emphasizing the peak and terminal drop from the peak at 3.5 kilocycles (drop to 2.4 kilocycles). It is 0.025 second in duration, and shows additional weak peaks at 2.4 and at 5.0 kilocycles (see Rattle Call). The function of the single note is unclear.

A Wicka Call (fig. 28c) was emitted between two Rattle Calls by an adult male interacting with and feeding a juvenile male at Kuala Selangor, Malaya. The call lasted 1.0 second and contained 14 notes of two types, a tall note (T), and an inverted, V-shaped note (V) emitted in the sequence: T V V T V T T V V T V V V T. The tall notes, apparently the very rapid banded-note equivalent of other species' Wicka Calls, varies from an almost solid, vertical note 0.005 second in duration, to a slower (0.025 second duration), almost banded note with emphasis on a harmonic tone at 2.0 kilocycles, and with weaker "bands" at 1.0 (fundamental tone), 3.0, 3.9, 4.9, and 5.9 kilocycles. Those tall notes are faster and the bands more obscured than in *D. javanense*, and the note is pitched lower. The inverted, V-shaped note is 0.015 to 0.025 second in duration, emphasized at its peak (variously 2.0 to 2.6 kilocycles, apparently an initial harmonic tone, for a faint fundamental tone is evident in some notes at 1.0 kilocycles). There is a moderate emphasis on a higher harmonic tone at 3.3 to 3.8 kilocycles. Although variable, some of these inverted, V-shaped notes closely resemble in pitch and form the comparable note of *D. javanense*; usually the pitch is slightly lower, however.

The Kow-Kow Calls correspond to the

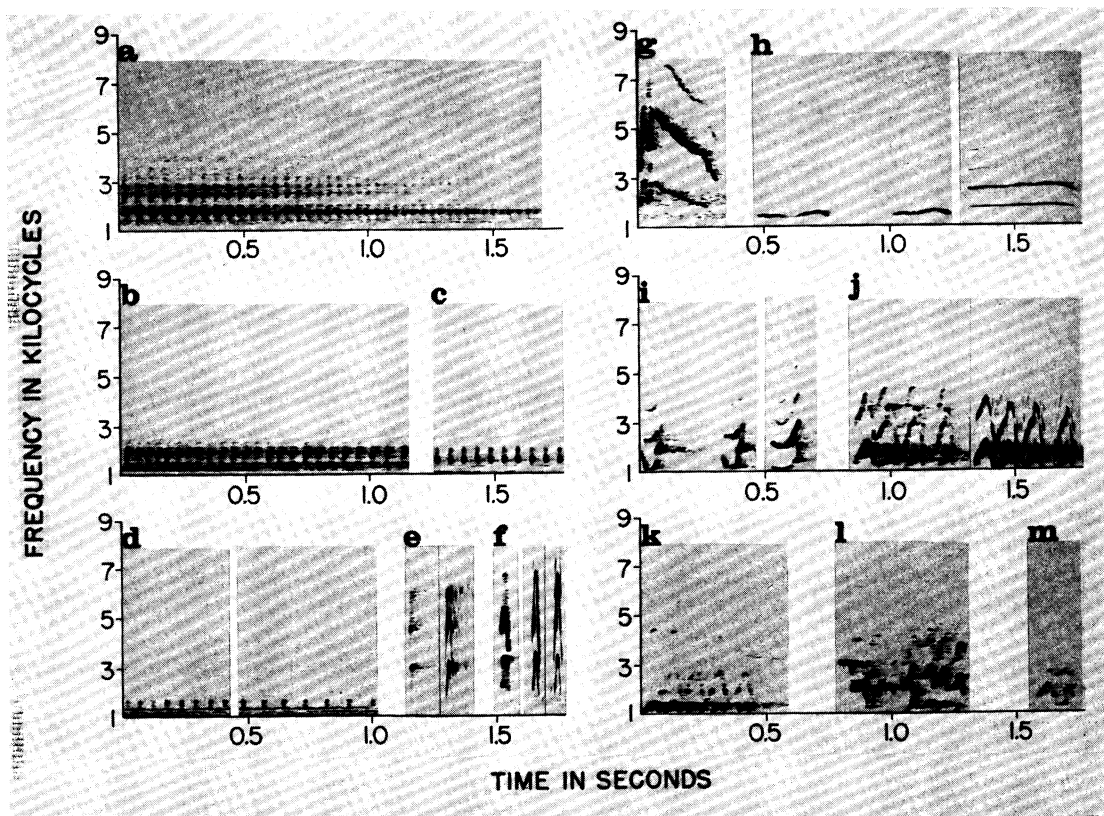


FIG. 36. Sound spectrograms of drumming and vocalizations of *Chrysocolaptes lucidus*, *Gecinulus viridis*, two species of *Meiglyptes*, *Hemicircus concretus*, and *Mulleripicus pulverulentus*. a. Drumming of *Chrysocolaptes lucidus*, complete except for final 4 beats, India. b. Drumming of *Gecinulus viridis*, complete burst, Thailand. c. Drumming of *Meiglyptes tukki*, beats 13 to 22 of 58-beat burst, Malaya. d. Drumming of *M. tristis*, parts of 31-beat burst showing beats 3 to 10 (compare with c) followed by beats 25 to 31 (notice slowdown), Malaya. e. Pit Call of *M. tristis*, one note followed by same note, WB, Malaya. f. Pit Calls of *Hemicircus concretus*, one call followed by same call, WB, then another call, WB only, Malaya. g. Peew Call of *H. concretus*, Malaya. h. Mewing Calls of *Mulleripicus pulverulentus*, two consecutive calls by one bird of pair at nest, followed by single low call (shown 1 kc. lower than indicated, i.e., 1 kc. below previous Mewing Calls) of male at nest, all from Malaya. i. Dwot Calls of *M. pulverulentus*, first 2 notes are second and third notes of a 3-note Flight Dwot Call series given by male flying from nest, last note a separate single Dwot Call, Malaya. j. Whinny Calls of *M. pulverulentus*, two different 4-note calls, second call WB, Malaya. k. Whinny Call of *M. pulverulentus*, 5-note call, Malaya. l. Dropping Whinny Calls of *M. pulverulentus*, two consecutive calls by one or two birds of pair, Malaya. m. Short Whinny Call of *M. pulverulentus*, Malaya. Note that a-d and second part of h are at 1 kc. lower than indicated in figure. All sonagrams are narrow band unless indicated wide band by WB.

Kow-Kowp Calls of *Dinopium javanense*, but are even more like the Kjaeck Calls of *Picus viridis* and *P. vittatus* than is the Kow-Kowp complex of *D. javanense*. These calls are extremely variable, with possible geographic or at least seasonal variation in the prevalence of certain notes of the call. One burst of calls of a single individual in Thailand contains a set of five, short, drop-

ping notes, a pause, and a set of seven notes differing greatly among the first, second to fourth, and fifth to seventh notes, all given within 1.35 seconds. This group of calls (fig. 271) embodies nearly all the observed variation in Thai, Malayan, and Indian calls, although extremes are not pronounced.

Kow Calls (fig. 27m, p) are single to triple

notes, occasionally interjected within the Kowk Call, which simply is the long, series version of the Kow Call. These calls emphasize as many as five tones, approximately at 1.5, 3.1, 4.3, 6.0, and 7.0 kilocycles. The tone (first harmonic) at 3.1 kilocycles usually is dominant, followed by strong tones at 4.3 kilocycles, and to a lesser extent at 1.5 kilocycles (fundamental tone). Often the fundamental tone is as weak as the higher pitched harmonic tones. Sound tends to tail beyond the peak of the dominant tone, connecting notes at this pitch in series calls; this tailing tendency is exhibited weakly or not at all at other tones.

Most Kow-Kowk notes have a peak, usually at the beginning of a note, and many are either double peaked or consist of two separate elements each dropping from a peak, hence constituting a compound note. Initial notes of longer calls tend to be simpler and more horizontal, and often they are longer than later notes of a call. One variant initial note drops from a peak rapidly, then is horizontal for a variable time; such notes are the longest (0.09 to 0.12 second) of the Kow-Kowk notes. Compound notes or double peaked notes tend to produce sound over a wider range of pitch than the single-peaked notes. Some compound notes, especially notes of a call recorded in India, have virtually parallel elements, the fundamental dropping slightly from 1.7 to 1.2 kilocycles, but the higher pitched harmonics falling from peaks at diverse frequencies (the range in pitch is distorted at higher frequencies on sonagrams, so the parallel, compound elements of the fundamental tone are progressively separated, and their drop in frequency is enhanced in tones at higher frequencies). Such notes appear multi-banded (fig. 27p). Other, double-peaked notes with the elements almost separated have the separation obscured by intense sound throughout the note (in the dominant 2.8 to 3.4 kilocycle tone) and tailing thereafter. Variant shorter, single-peaked notes, such as the first note of a 12-noted Kowk Call from Malaya, lack the dropping portion of the other notes, and as essentially inverted, U-shaped notes, are identical in all respects to Kow Call notes of *Dinopium javanense* and to some Kip Calls of *Picus vittatus*.

Kow-Kowk notes vary in the emphasis given to initial rising and terminal falling elements. In some cases these receive moderate emphasis, as in Kjaeck Calls of *Picus vittatus* and *P. viridis*. The

duration of the diverse notes varies from 0.03 to 0.12 second; single-noted Kow Calls with their "tails" may be 0.30 second in duration. Two-noted calls (eight examples) are 0.23 to 0.27 second in duration, or including tails, about 0.50 second long. Three-noted calls (two examples) last 0.35 and 0.36 second, or 0.5 to 0.6 second with the tails. Kowk Calls (fig. 27k, l, o, q) containing four to 12 notes varied in duration from 0.33 to 1.63 seconds, excluding tails, and giving a tempo of 7.4 to 12.5 notes per second (10.23 note average for eight calls). Terminal notes of a call usually are shorter, sometimes much shorter (less than half as long as initial notes) than initial notes within a call, but in two cases (of 16) there is no variation in their duration or terminal notes are longer than initial notes of a call.

The Kow Call is given in flight or when the birds are perched, whereas Kowk Calls normally are flight calls. This parallels the situation in *Dinopium javanense* (Kow-Kowp Calls) and in the series Kjaeck Call of *Picus vittatus* and *P. viridis*. It is worthy of note that the Kjack Call of *Picus canus* differs from Kjaeck Calls of its relatives in the wavering (like small peaks) of its notes; this condition is suggested in some double notes of *Chrysocolaptes lucidus*. Also of interest is the fact that among genera *Gecinulus*, *Blythipicus*, *Reinwardtipicus*, and *Meiglyptes*, possibly related to *Chrysocolaptes-Dinopium* (*Reinwardtipicus validus* currently is treated universally as congeneric with *Chrysocolaptes lucidus*!), there exists no equivalent, or call similar to the Kow-Kowk, Kow-Kowp, and Kjack-Kjaeck flight calls of *Chrysocolaptes*, *Dinopium*, and *Picus*, respectively (the Kwa Call of *Gecinulus viridis* is the sole possible exception).

The Rattle Call (fig. 28d, e) is a variable, rapid series of inverted U-shaped notes with strong (Malayan) or weak (Thai) overtones. I analyzed 10 Malayan Rattle Calls of six to 51 notes (average 21.7 notes per call), lasting 0.45 to 3.55 seconds (average 1.55 seconds). The overall rate of delivery varied between 11.3 and 16.9 notes per second, but some calls, especially the longer ones, have one or even two or three portions of the call that are speeded up to a rate of 20 notes per second. Indeed, seven of the 10 calls analyzed have distinctive shifts in the rate of delivery of notes, in the pitch of notes, or in the form of the individual notes, or any combination of these. These variations give a

pulsating, wavering quality characteristic of this species.

As many as five variant notes (fig. 28d, e) may be distinguished in Malayan Rattle Calls, and all five are contained in the longest of those calls. One type is a symmetrical, inverted U-shaped note accented at the peaks and with weak to moderate, symmetrical legs. A second type is similar, but shows no, or only a very weak rising portion, thus being asymmetrical. A third type resembles the second, but not only the rising portion, but most of the peak as well is omitted, leaving only a strong dropping portion—this type characterized both recorded Thai Rattle Calls in their entirety. A fourth type resembles the third type, but the remaining terminal portion of the peak is horizontal, thus forming an angle with the dropping portion. Finally, a fifth type of note is fully flat-topped and asymmetrical, emphasizing the dropping portion of the note, the full, flat peak, and the upper rising portion as well (forming an inverted block-J shaped note). By far the greatest number of notes are of type 1 and, to a lesser extent, type 2. Notes of types 3, 4, and 5 are characteristic of those sections of calls that change in tempo, or in pitch or both.

In the 51-note call containing all five types of notes, the first seven notes, and notes 36, 38, and the last two notes are of type 1. Notes 41 to 43, 45, 47, and 48 are of type 3, note 44 is of type 4, and note 46 is of type 5. All other notes are of type 2. The initial six notes are run together, nearly on top of one another; they also vary in pitch (the dominant tone peaks at 3.0, 3.1, 3.1, 2.9, 3.0, and 2.9 in these notes). The portion of the call from note 41 to 48 differs in the type of notes contained, and slightly in pitch (rise from 2.8 to 3.0 kilocycles). This Rattle, lasting 3.55 seconds, precedes a 1.05-second Wicka Call, which leads into a 17-note, 1.28-second Rattle Call, all given by an adult male interacting with (and feeding) a juvenile male. The second Rattle Call, shorter than the first, also differs in other ways. All its notes are of type 1 (one note is flat-topped, but otherwise symmetrical). It does not vary in tempo. In contrast to the dominant initial harmonic tone in the first Rattle Call, that tone and the next higher tone at 4.2 kilocycles are codominant, and the equal fundamental tone and next higher harmonic tone also are strong. The notes vary little in pitch, except for a slight rise (from 2.5 to

2.8 kilocycles in initial harmonic tone) in its beginning. Other Rattle Calls from Malaya have codominant tones at 2.6 or 2.7 and 3.9 to 4.3 kilocycles (four instances), codominant tones at 3.9 to 4.3 and at 5.4 to 5.7 kilocycles (two cases), a dominant tone at 2.7 kilocycles (one call), or a dominant tone at 4.3 kilocycles. All (four to five) tones receive some emphasis, however. The duration of the notes lasts from 0.015 to 0.03 second, but there is little variation within calls.

The Rattle Calls of *Chrysocolaptes lucidus* in Malaya most closely resemble in general form, in stress on the overtones, in pitch, and in tempo of delivery, the Fast Long Call of *Dinopium rafflesii*. The latter call is, however, much more regular throughout, and there is no major change in pitch or form of the notes within a call. Also similar, and wavering in pitch is the higher pitched, slower Rattle Call of *Blythipicus rubiginosus*. *Gecinulus viridis* also has a Rattle Call that is wavering, although the notes are more different in form from those of *C. lucidus* than are notes of those calls of other species just mentioned. The Long Call of *Dinopium javanense* has notes similar in form to those of the Rattle Call of *C. lucidus*, but overtones are much weaker, the pitch differs somewhat, and the call is non-wavering. Rattle Calls of *Dinopium javanense* and of *Blythipicus pyrrhotis* are composed of more vertical notes covering a wider range in pitch than those of *C. lucidus*. Finally, the Rattle Call of *Reinwardtipicus validus* is a non-wavering call with weak harmonic tones, resembling the Long Call of *Dinopium javanense* rather than the Rattle Call of *C. lucidus*.

The Thai Rattle Calls of *C. lucidus*, only three of which were recorded, differ rather strikingly from the Rattle Calls recorded in Malaya (indeed, two different subspecies are involved, *guttacristatus* in Thailand and *chersonesus* in Malaya). A basic factor indicating their relationship is the shape of the Thai Rattle Call notes, which is exactly that of the uncommon type 3 notes of Rattle Calls in Malaya. The Thai Rattle Calls are slightly slower (10 to 12 notes per second), the initial harmonic tone at 3.1 to 3.5 kilocycles, slightly above that of Malayan calls, is dominant, and other tones, including the fundamental tone are much weaker. All three Thai calls also show moderate to strong tailing of sound in the dominant tone, and indeed, this sound effectively obscures individual notes of two of these calls; calls from Malaya lack this

effect. The three Thai calls contained six to 16 notes, and lasted 0.50 to 1.58 seconds without the tail of sound that adds substantially (50 percent to shorter calls) to the duration of the calls. Each note is 0.025 to 0.03 second in duration, averaging longer than notes of calls of Malayan birds, including their type 3 notes. Other than the Rattle Call notes from Malaya of this type, the only other notes somewhat resembling the Thai Rattle Call notes are notes of some Long Calls of *Dryocopus javensis*.

Rattle Calls are given either in flight or while a bird is perched. They seem to connote aggression directed at an intruder, at another species of woodpecker (*Celeus brachyurus*, one incident), or at a nearby conspecific individual (adult male to young male). The difference in Rattle Calls between Thai and Malayan birds remains a subject of inquiry.

BAMBOO WOODPECKER

Gecinulus viridis

Figure 37

The little-known Bamboo Woodpecker ranges from southern and eastern Burma, central Thailand and Laos to Malaya, being replaced by the very closely related *Gecinulus grantia* north of that region (Nepal to southeastern China, Vietnam, and central Burma). As far as is known, the Bamboo Woodpecker is confined to areas where bamboo grows extensively, that is, bamboo "brakes," and mixed bamboo and secondary forest. I observed this Woodpecker at Ulu Gombok in the hills northeast of Kuala Lumpur, Malaya, and at two localities in northern peninsular Thailand (west of Ratburi, and west of Petburi). In the area west of Petburi the Bamboo Woodpecker was common in scattered, dense clumps of large bamboo, and mixed second-growth woodland. Sympatric at this last locality with *Celeus brachyurus*, *Picus vittatus*, and *Picus canus*, it outnumbered those three species, and, unlike them, the Bamboo Woodpecker was found only in bamboos.

In the field the Bamboo Woodpecker is generally inconspicuous, except for its light tapping while foraging, and the flash of its pale bill on the wavering shadows of the bamboo. Its actions in "hugging" the bamboo stalk are peculiar and characteristic. All three toes are directed more or less forward (fig. 37) and its legs are spread and

clasped around the stalk such that the abdomen appears to "ride" on the stalk. The tail seems weakly appressed, or not appressed at all to the stalk. These actions are especially noticeable when the bird is perched along the smooth surface of the stalk between nodes. Apparently the bamboo stalks are sufficiently smooth to make climbing somewhat difficult for the birds, for they perch more like a "normal" woodpecker when they reach the (rough-surfaced) nodes. I also noted that the many cavities apparently excavated by this species (see below) invariably are above a node, such that a woodpecker would be grasping the nodal surface with its toes when excavating the cavity. I saw one Bamboo Woodpecker perched in a sapling briefly at Ulu Gombok, but all others were seen only in bamboos.

Foraging takes place in both live and dead bamboo stalks, usually within 5 or 6 meters of the ground. As in many picids, Bamboo Woodpeckers disturbed by an intruder but not sufficiently alarmed to fly off tended to move upward in bamboos beyond levels at which they usually fed—too, their tapping seemed especially weak and haphazard when foraging (possibly displacing) at such heights. Foraging birds move rather slowly, methodically working up a stalk, backing frequently to look over an area missed, or to one side. They glean from the surface (presumably ants), and tap regularly, usually without much force, and rarely in sustained bursts. Occasionally they drilled through the bamboo in about 10 taps of the bill, making a little round hole (such holes were seen commonly in bamboo groves at the Thai localities, and less commonly in Malaya where I saw but two birds). In dead or broken bamboo stalks Bamboo Woodpeckers forage especially at the broken places, in crevices and various holes in the surface. Ants seem to be a major, if not the main food of this woodpecker.

I found no nests or cavities in bamboos at Ulu Gombok, where I saw two Bamboo Woodpeckers in Malaya. At the two Thai localities, cavities appropriate in size for this species were seen commonly in bamboos. These cavities were ascribed to *Gecinulus viridis* because this was the most common woodpecker there, the openings seemed the size of this species, and the restriction of the woodpecker to bamboo makes likely its nesting in bamboos. Of other sympatric woodpeckers at the Thai localities, *Celeus brachyurus*



FIG. 37. Female Bamboo Woodpecker (*Gecinulus viridis*) west of Petburi, Thailand. Note pale bill and clamping of (3) toes at node of bamboo shaft.

usually excavates cavities in ant nests, and *Picus vittatus* and *P. canus*, both larger than *G. viridis*, seemed too large to utilize many of the cavities in bamboos (those in medium-sized stalks). Also, a nest of *P. vittatus* was found in a palm stub, and both species of *Picus* foraged in trees, not in bamboos. Openings of cavities in the bamboos inevitably were situated above a node, at about the appropriate distance above the node to allow for the head-to-leg distance of *Gecinulus viridis*. The entrances lead down through the node, and into the next lower internode, giving a cavity up to 25 centimeters in depth. However, none of the cavities appeared to be occupied at the time of my visit, which I surmise to have been prior to the nesting period. No nests are known from Malaya, or Thailand.

I saw no displays of this rather stolid wood-

pecker. Many birds maintained a semi-erect crest, which is short and "bristly," like that of *Celeus brachyurus* (which *G. viridis* most resembles in body form and shape, except that its tail is longer than that of *brachyurus*).

Bamboo Woodpeckers drum in bamboos, producing (fig. 36b) rapid, rather low bursts, weaker generally than those of *Celeus brachyurus* or *Picus vittatus*. Most bursts lasted about one second; three that I was able to record and analyze included two longer bursts of 1.12 seconds each, and a short burst of 0.38 second duration. The long bursts contained 21 beats, delivered at a rate of 18.8 beats per second, and 24 beats rendered at a rate of 21.4 beats per second. In both cases the tempo decreased somewhat (from 21 to 17, and from 24 to 19 beats per second, respectively, in the initial and terminal

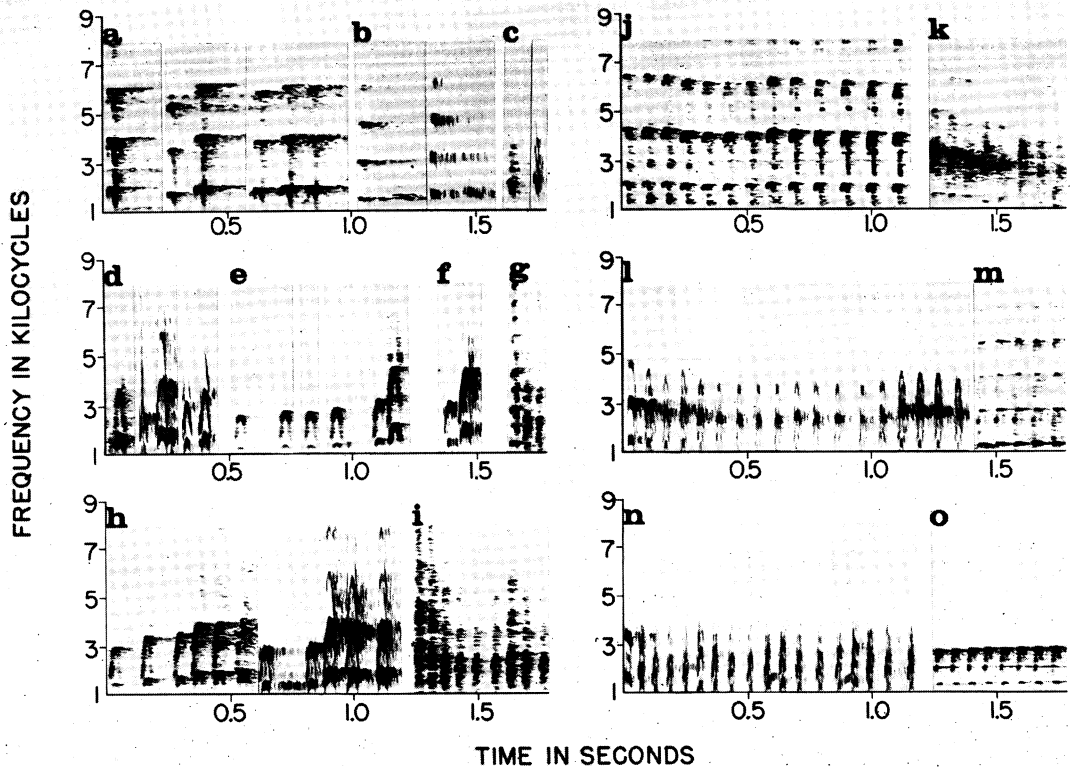


FIG. 38. Sound spectrograms of vocalizations of *Blythipicus rubiginosus*, *B. pyrrhotis*, *Reinwardtipicus validus*, and *Gecinulus viridis*. a. Pit Calls of *Blythipicus rubiginosus*, single note, double note, then triple note, Malaya. b. Pew Call of *B. pyrrhotis*, followed by same call, WB, Malaya. c. Pit Call of *Gecinulus viridis*, then same note, WB, Thailand. d. Pit Calls of adult *Reinwardtipicus validus*, single note, followed by 2 double notes, both WB, Malaya. e. Pit Series Call of adult *R. validus*, notes 1 and 2, then 5, followed by 8 to 10, of 10-note call, Malaya. f. Pit Series Call of adult *R. validus*, terminal 2 notes of 10-note call (not same call as e), WB, Malaya. g. Short Rattle Call of *B. pyrrhotis*, one series of several by flying bird, Malaya. h. Pit Flurry Call of *R. validus*, followed by another Pit Flurry Call (lacks initial note), WB, Malaya. i. Pit-Rattle Call of *B. pyrrhotis*, Malaya. j. Rattle Call of female *B. rubiginosus* held in hand, Malaya. k. Rattle Call of *G. viridis*, initial 8 notes of 16-note call, Thailand. l. Rattle Call of *G. viridis* (note pitlike introductory note, wavering pitch, changes in tempo, and loudness), WB, Thailand. m. Juvenile Begging Rattle Call of *R. validus*, 5 notes from continuous series uttered by young being fed, Malaya. n. Rattle Call of *B. pyrrhotis*, initial 18 notes of 26-note call (compare with l), WB, Malaya. o. Rattle Call of adult *R. validus*, notes 13 to 20 of 20-note call, Malaya. All sonagrams are narrow band unless indicated wide band by WB.

one-half second of the calls) throughout the burst. The short drumming burst contained nine beats (23.7 beats per second). The drumming of *G. viridis* is in shorter bursts, the tempo is greater throughout the burst, and the slowdown is much less marked than in *Celeus brachyurus*.

I was fortunate to hear six different calls of the

Bamboo Woodpecker, but only four were recorded and two of the four barely were analyzable. A peculiar Pit Call is one of two single-note calls that I heard. Three Pit Calls (fig. 38c) uttered by a male disturbed by my presence are short (0.04 second duration), vertical notes, composed of an inverted, V-shaped element

followed by a second rising element. Emphasis is on the initial peak and subsequent fall in the dominant tone (peak at 2.3 kilocycles, dropping to 1.6 kilocycles), and the trough between the two elements in the next higher-pitched tones at 2.7 and 3.8 kilocycles. This call needs study—it seems different from pitlike calls of other picids.

The Kwa Call was recorded once, poorly, during an interaction between a male and a female Bamboo Woodpecker, and conceivably it may be a variant Wicka Call note (see below). The note, 0.11 second in duration, drops from an initial peak to a plateau, which it reaches one-third of the way through the note—the plateau continues to the end of the note. The plateau is represented by tones at 0.7, 1.4, 2.1, 2.8, and 3.5 kilocycles, but only the second and third of these are emphasized. The peak of the dominant (apparent second harmonic) tone is at 2.7 kilocycles, and the next lower-pitched peak of the tone is at 1.75 kilocycles. This call curiously is the reverse of the Dwot Call note of *Mulleripicus pulverulentus*, which plateaus or rises slightly, then rapidly to a terminal peak, but is at a lower pitch.

A low “wee-a-wee-a-wee” burst from a pair of Bamboo Woodpeckers nearly hidden in the dense base of a bamboo cluster apparently represents a Wicka Call. It was not recorded and obviously is in need of elucidation.

The most commonly heard call of *G. viridis* is a Rattle Call (fig. 38k, l) very like that of the Bay Woodpecker, but slower. Characteristic of the Rattle Call of the Bamboo Woodpecker (and that of the Bay Woodpecker, and Greater Goldenbacked Woodpecker) is a wavering quality, largely the result of a shift in pitch and in loudness during a Rattle Call. The call pulses either regularly (fig. 38 l) or irregularly, with weaker notes of lower pitch between the segments containing louder, higher pitched notes.

Six recorded Rattle Calls of 0.48 to 1.34 seconds in duration contained seven to 18 notes, delivered at 13.43 to 14.58 notes per second. There is no appreciable change in tempo during a call. The vertical notes are either diffuse, or peaked showing overtones but with most sound included between 2 and 4 kilocycles. A characteristic of the calls is the lack of the fundamental tone in notes found in the middle or end of the call, and especially in their lower-pitched portions. The dominant tone is the initial overtone peaking at 2.2 to 3.4 kilocycles. One typical call

of 16 notes (fig. 38k) shows an initial note with peaks at 1.7, 3.4, 5.0 and 6.7 kilocycles. Diffuse sound surrounds the dominant peak (3.4 kilocycles). The first six notes are intense, with respective peaks of the dominant tone at 3.4, 3.4, 3.2, 2.7, 3.0, and 2.6 kilocycles. The fourth and six notes have more diffuse sound at a pitch extending above that of the other notes. Highs of 2.7 (seventh note) and 2.5 kilocycles (fourteenth note), and a low of 2.3 kilocycles (eleventh to thirteenth notes) mark the remainder of the call. Fundamental peaks are moderate in notes one to five and eight, weak in notes six, seven, 15, and 16, and very weak or lacking in other notes. Other calls vary somewhat, but three shorter calls usually have two higher pitched segments separated by a low-pitched segment, and two longer calls are irregular in pitch (variation in dominant tone 2.2 to 2.5 kilocycles), or regularly drop then rise again like that described above in detail. These calls closely resemble some Rattle Calls of *Blythipicus pyrrhotis* in the form of the notes, as well as in the details mentioned above.

The Rattle Call seems to be an agonistic call, heard when apparent chases were underway (none observed well), or when disturbed by an intruder.

A Kweek Call was heard several times during apparent conflicts between two individuals. Five or six notes were heard in each call, sounding like “Kweek-week-week-week-week” or “Keek-keek-keek-keek-keek.” One variant call I recorded (fig. 39a) sounded like “Kwi-kwi-week-kweek-kweek.” The notes of the latter call vary from 0.06 to 0.30 second in duration. Typical kweek notes (fig. 39a, last note) show a drop followed by a rise, sometimes stepped, to a flat-topped peak, with a tail of sound extending beyond it at the dominant (initial harmonic) tone. Three or four tones are visible on sonagrams, with emphasis on the peak of the initial harmonic tone (peak at 3.0 kilocycles), and the rising portion of that tone and the next higher pitched tone. The fundamental tone is at 1.4 to 1.6 kilocycles. Some notes of the two calls analyzed exhibit an extra, horizontal element located at 3.8 kilocycles, between the normal tones at 3.1 and 4.6 kilocycles. The two calls are 1.65 and 1.15 seconds in duration. These Kweek Calls are extremely like those of the Kweek Call of *Celeus brachyurus*. My limited samples show differences as follows: the Kweek Call of *G. viridis* is somewhat faster, the rising portion of the notes

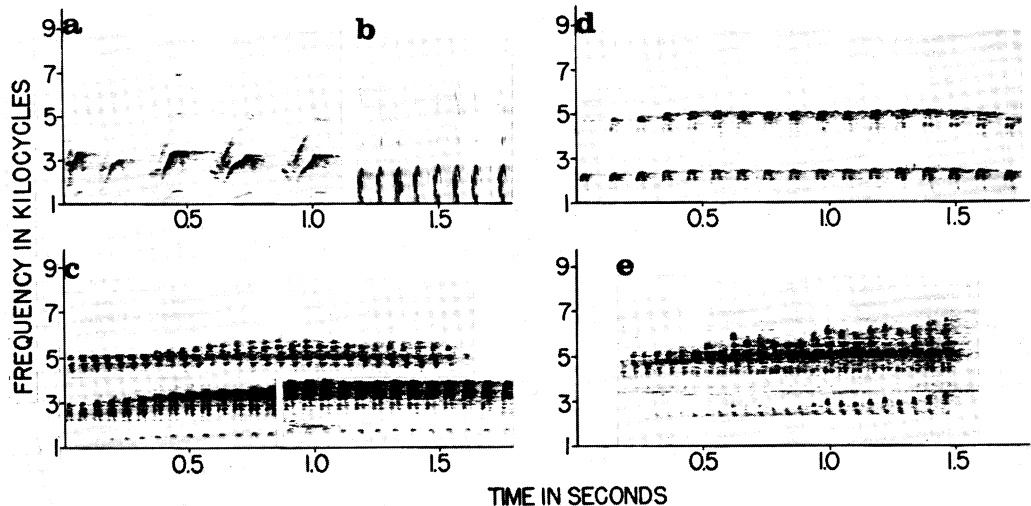


FIG. 39. Sound spectrograms of vocalizations of *Gecinulus viridis*, *Reinwardtipicus validus*, two species of *Meiglyptes*, and *Hemicircus concretus*. a. Kweek Call of *Gecinulus viridis*, Thailand (note variation in duration of notes). b. Juvenile Series Call of *Reinwardtipicus validus*, 8 notes from long series, WB, Malaya. c. Trill Calls of *Meiglyptes tristis*, complete call shown above 4 kc., and of *M. tukki*, notes 2 to 15, then 31 to 43 of 43-note call, shown below 4 kc., both Malaya. d. Long Call of *M. tukki*, complete except for first note, Malaya. e. Trill Call of female *Hemicircus concretus* (disregard horizontal insect sound at just above 3 kc.), compare with (c), Malaya. All sonagrams are narrow band unless indicated wide band by WB. See text.

is sharper (more rapid) and hence the notes are more vertical generally, the flat-topped portion is longer, and the rising portion of higher pitched overtones is less emphasized such that the notes appear less complex on sonagrams. This comparison is between the full kweek notes of *G. viridis* and the kweek notes of *C. brachyurus*; taller ("kwi") notes of *G. viridis* have no counterpart (but see the Keek Call of *C. brachyurus*) in Kweek Calls of *C. brachyurus*, in my limited experience. The calls of these two species function similarly in conflicts. There are flat-topped notes in some Keek Calls of *Picus mentalis* that resemble the notes of the Kweek Call of *G. viridis*.

I heard four Long Calls of the Bamboo Woodpecker, but was unable to record them on tape. The calling bird, a male, perched in bamboo at Ulu Gombok in Malaya. The call, rendered in my notes as "Keé-kee-kee-kee-kee-kee-kee" or

"Keep-kee-kee-" etc., with slight emphasis on the first note. The clear, loud call, seemingly a territorial proclamation call resembles most closely the (Pee) Long Calls of *Picus vittatus* and *P. canus*, but comparison must await further data.

MAROON WOODPECKER

Blythipicus rubiginosus

Figures 40, 41

The Maroon Woodpecker is a denizen of dense forests in lowlands and lower hills of Sundaland from peninsular Thailand to Borneo and Sumatra. It is infrequently seen in dense secondary forest, favoring primary forest with a heavy understory. In such a setting it may be glimpsed, for it is ever on the move and does not



FIG. 40. Male adult Maroon Woodpecker (*Blythipicus rubiginosus*) in hand at Pasoh, Malaya. Note bill color, shape of tail feathers, and partly raised crest.

permit continuous observation, appearing as a brown or black bird with a conspicuous orange-yellow or lemon yellow bill (fig. 40). The darkness obscures its reddish dorsal feathering, and its red (adult) eyes. Like the Okinawa Woodpecker (*Sapheopipo noguchii*; Short, 1973b), a bird of very similar habits, the pale-billed Maroon Woodpecker flicks its wings as it calls at an intruder. I never saw this species more than 6 or 7 meters above the ground, and it was usually

seen initially within a meter or two of the ground. Like many woodpeckers, if not alarmed to the point of immediately taking flight, it reacts to an intruder by calling and climbing upward. Once it gets a good look at the intruder, however, it flies off into the undergrowth, there to call for a minute or two longer if not disturbed further.

Foraging Maroon Woodpeckers attack live trees, rotten stubs, and fallen logs, hacking them



FIG. 41. Male adult Maroon Woodpecker (*Blythipicus rubiginosus*) in hand at Pasoh, Negeri Sembilan, Malaya. Note bill structure and color, partly raised crest, and wing barring.

to pieces if they are sufficiently rotten, and extracting insects from within. They go to small, rotten logs less often than does the Okinawa Woodpecker, but larger fallen logs frequently are used for foraging. Normally, foraging takes place as the woodpecker proceeds up a stub or tree from near ground level up 2, or rarely 3 or more meters, then the bird flies to the base of another tree and begins anew. In live trees mosses or other debris may be torn apart, and pecking initiated at the point of contact of these materials with the tree. I have circumstantial evidence that deep, pitted excavations, four or five in a cluster, are attributable to the Maroon Woodpecker. The pits seen on two occasions, were in the trunks of live trees. One bird fled from such a site, but whether it was excavating, or simply visiting (perhaps revisiting) the holes

is uncertain. Similar, shallower pits, measuring 5 by 2 centimeters, and 1 centimeter deep, are excavated in stubs in five to seven minutes. The woodpeckers forage alone, or loosely in pairs, maintaining occasional contact vocally, but not feeding together in the same trees.

I found no nests, but saw young birds with adults in February and March. Immature birds were taken in mist nets at Pasoh in Negeri Sembilan during February by David Wells. The breeding season apparently is during December and January in Malaya. Nests have been reported in January in Borneo (Smythies, 1960, p. 337), and in February in Malaya (Robinson, 1928, p. 108).

Rarely were two birds seen together, and then by chance as they foraged in separate trees. I saw only two displays, other than vocal displays,

namely Wing Flicking and Crest Raising. As mentioned above, Wing Flicking accompanies calls, that is, the Pit Call of an apparently agitated bird. The wings are raised slightly, then rapidly brought into a normal position in Wing Flicking. This display apparently is a signal, either denoting alarm, mild aggression, intent to fly, or any combination of these. Crest Raising was seen in a hand-held bird taken from a mist net; it was noted especially in a male (males have a red nuchal patch that can be erected into a short crest, as in fig. 41). Probably it indicates aggression. I failed to detect this display in birds in the wild.

There is no report of drumming by this species or of the drumming of the related Bay Woodpecker. Evidence for this activity should be sought during the pre-breeding period (October to December).

Diverse calls noted in Malaya include a Pit Call (call note, a "pit," "pyick," "pyeek," or "kyuk," or a double-noted "kyik-ik"), a Rattle Call, a Keek Call, a Pew Call, and a Pee or Long Call. All of these were recorded except the Keek Call, which may be simply an intense Pit Call. The Pew and Pee calls often are rendered in a Pew-Pee series, with no pause between them, combined into a double call.

The Pit Call (fig. 38a) is the metallic note ascribed to this species by various authors, and the note commonly uttered when the bird is disturbed. It usually is accompanied by Wing Flicking simultaneously with the call, as noted above. A calling bird, after it is flushed, continues to give the call for several minutes after it commences foraging at another site before becoming silent. The note is inverted U-shaped, with strong overtones and a strong tail of sound carrying beyond the inverted U in overtones as well as in the fundamental tone. The fundamental tone, at 1.9 to 2.1 kilocycles (30 examples), usually receives the greatest emphasis, or if not it is emphasized equally with, or is surpassed by the tone peaking at 5.7 to 6.2 kilocycles, or, occasionally, that at 3.8 to 4.4 kilocycles. The harmonic tone at 3.8 to 4.4 kilocycles is often moderately intense, and there is a weaker tone at 7.6 to 8.0 kilocycles. The call note is 0.03 to 0.05 second in duration excluding the tail of sound which may cover 0.30 second or more. Two double notes and one triple were recorded. All three of these compound calls exhibit a step-up in pitch (from 1.7 or 1.8 to

2.1 kilocycles, fundamental tone) from the first to the second (third as second) note. The initial note is shorter (0.03 versus 0.04 second) in all three of these calls. The double calls lasted 0.40 second, and the triple call 0.47 second, including the terminal "tail." Notes are nearly symmetrical, or the dropping leg of the inverted U is emphasized. There is a close resemblance of the Pit Call, and especially the compound Pit Calls to the notes of the Pit Series Call of *Reinwardtipicus validus*. The Pit Call also resembles the shorter Keep or modified Kip Calls of *Picus vittatus*, but is higher pitched.

The Rattle Call (fig. 38j) is a series of notes resembling notes of the Pit Call, but slightly higher in pitch, with weaker (or no) tails, and weaker, higher-pitched overtones than Pit Call notes. The dominant tone is, in all four examples analyzed, the initial harmonic tone peaking at 3.8 to 4.7 kilocycles; the moderately intense fundamental tone peaks at 1.9 to 2.3 kilocycles, and there are weaker overtones at 5.7 to 6.4 kilocycles, and at about 8.2 kilocycles. Individual notes vary from 0.025 to 0.040 second in duration, with no pattern of variation apparent in any single call.

Four Rattle Calls that were analyzed lasted 0.47 to 1.28 seconds, contained six to 14 notes, and were rendered at 11.0 to 12.7 notes per second with a tendency for a slowdown in tempo during a call. All four calls show a wavering tendency, that is, variation in pitch. The six-noted call rises to a peak from the first to fourth note (from 3.8 to 4.3 kilocycles in dominant tone) then holds at that pitch. The other three, longer calls (12 to 14 notes each) start at a high pitch, drop, then either continue at the lower pitch (two calls), or show another rise in pitch late in the call. The last-mentioned call starts at 4.4 kilocycles (peak of dominant tone), drops to 4.2 kilocycles, then rises to 4.35 kilocycles (at eighth note) before dropping back to 4.2 kilocycles. These calls resemble the wavering Rattle Call of *Chrysocolaptes lucidus* and the non-wavering Rattle Call of *Reinwardtipicus validus*, both of which are lower pitched and tend to be delivered at a more rapid rate. A Crest-Raising male taken from a mist net gave a Rattle Call, repeated several times, but uttered no Pit Call until it was released. The Rattle Call also followed Pit Calls in two instances during observations of foraging Maroon Woodpeckers. The Rattle Call thus seems to indicate either greater

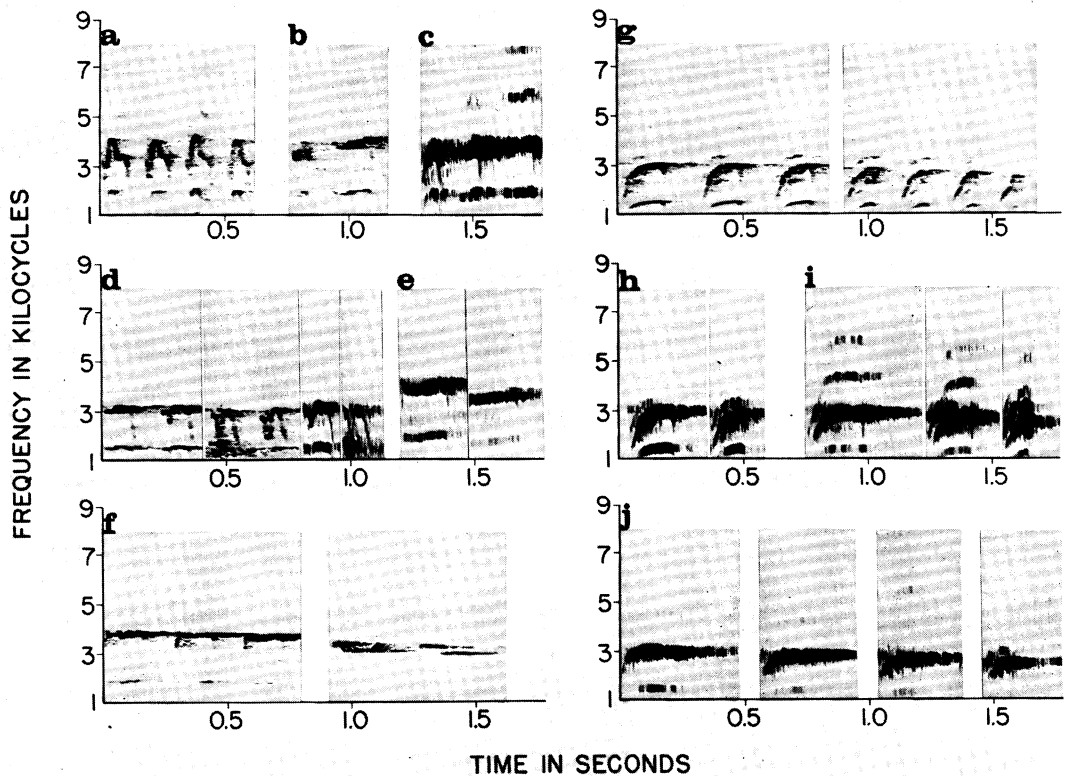


FIG. 42. Sound spectrograms of vocalizations of species of *Blythipicus*. a. Pew Call of *B. rubiginosus*, notes 6 to 9 of 13-note call, Malaya. b. Pew-Pee Call, shift from last Pew note, left, to first Pee note, right, of *B. rubiginosus*, Malaya. c. Pew-Pee Call, shift from last two Pew notes at left to first Pee note at right (middle note is intermediate), of *B. rubiginosus*, WB, Malaya. d. Pew Call of *B. pyrrhotis*, notes 5 and 6, then notes 12 and 13, followed by notes 5 and 12, WB, of a 14-note call, Malaya. e. Pee Call of *B. rubiginosus*, WB, notes 2, then 7 of Pee Call terminating Pew-Pee combination call shown in (b), Malaya. f. Pee Call of *B. rubiginosus*, notes 1 to 3, then 6 and 7 of 7-note call (notice peaks of first note, and compare with g to j), Malaya. g. Pee Call of *B. pyrrhotis*, notes 1 to 3, then 6 to 9 of 9-note call, Malaya. h. Pee Call of *B. pyrrhotis*, same call as in (g), notes 2 and 5 of 9-note call, WB, Malaya. i. Pee Call of *B. pyrrhotis*, notes 1, 5, and 11 of 11-note call, WB, India. j. Pee Call of *B. pyrrhotis*, notes 1, 3, 6, and 11 of 11-note call, WB, India. Sonagrams are narrow band unless indicated wide band by WB. Some terminal tails have been cut off to save space.

aggressiveness, or heightened alarm compared with the Pit Call, the former being more likely than the latter.

The Keek Call was heard once, from a startled bird foraging only two meters from me as I passed by. The series of notes, a "keek-eeek-eeek-eeek" sounded more like longer Pit notes than like a Rattle Call, and it is likely that these keek notes represent an extreme of the Pit Call.

The Pew Call is related structurally and functionally to the Pee Call. It is uttered sepa-

rately (fig. 42a), or in combination with the Pee Call (fig. 42b, c), which it precedes in such combined calls. Only three Pew Calls were recorded satisfactorily, permitting analysis, and two of these immediately preceded a Pee Call. The three Pew Calls contained 14 to 15 notes delivered in 2.23 to 2.32 seconds, at a rate of 6.22 to 6.46 notes per second. The individual notes are vertical, peaked notes compared with the horizontal notes of the Pee Call. The actual form of the notes varies from a rise to a peak, followed by

a drop to a step, then a fall in pitch, to a similar note preceded by an initial drop, or a stepped note with two dropping portions, one from the center of the step, and the other terminating it. Another variant form is the less vertical, longer note or two preceding the Pee Call, when that Call follows the Pew Call. These latter Pew Call notes are essentially intermediate between typical vertical Pew Call notes, and the horizontal Pee Call notes. Overtones are weak in the Pew Call, except for the dominant initial harmonic tone, peaking at 3.8 to 4.2 kilocycles. The somewhat weaker fundamental tone is at 1.8 to 2.2 kilocycles. Most of the sound is encompassed between the peak of the fundamental tone and that of the dominant tone, that is, between 1.8 and 4.3 kilocycles.

Pew Call notes are 0.07 to 0.13 second in duration, the shorter notes showing a weaker, shorter step and no initial dropping portion, in contrast to longer notes having a more marked step, and, often, the initial dropping segment. There is considerable variation in the intensity of various parts of each call, with no regular pattern evident. In the calls combined with Pee Calls, the dominant peak of the last note of the Pew Call is at the same pitch as the peak of the immediately following, initial Pee Call note. The Pew Call seems to be similar in function to the Pee Call, but one instance involving a Pew Call directed at an antagonist of the calling bird (two males burst from the woods after the calling, but I did not see their interaction) suggests the association of this call with agonistic behavior and encounters. The Pee Call serves perhaps more as a contact call between mated birds, and in territorial proclamation, but they doubtless overlap considerably in function. No calls of other picids closely resemble the Pew Call, except for the Pew Call of *B. pyrrhotis*, which see. The Kowk Call of *Chrysocolaptes lucidus* shows in some variant notes the initial peak found in the Pew Call of *B. rubiginosus*, but the latter call is higher pitched, with weak overtones, and the notes of the call differ markedly from most Kowk Call notes. It might be mentioned that no species of *Blythipicus*, nor *Sapheopipo noguchii*, *Gecinulus viridis*, or *Reinwardtipicus validus* has a flight call or any call resembling very closely the Kowk (flight) Call of *Chrysocolaptes* and *Dinopium*.

The Pee Call or Long Call (fig. 42e, f) of the Maroon Woodpecker is a loud, distinctive series of seven to 11 notes lasting 1.88 to more than

2.30 seconds and averaging 3.27 to 4.29 notes per second (six examples analyzed). Characteristic of the call are its long notes covering a narrow range in pitch, a drop in pitch of the notes throughout the call, a strong tailing of sound effectively connecting the notes, and weak overtones except for the dominant tone. The form of most notes is partly, even considerably obscured on sonagrams by intense, diffuse sound. Where their form is discernible, they give an appearance of double notes, that is, two slight peaks may be visible, or two distinct elements are present. The second (usually terminal) element, when present, may be a mere step appended to a dropping initial element, a separate nearly horizontal segment arising from near the end of the first element, or a discrete nearly horizontal element parallel to, and at a slightly lower pitch than the initial element. One call contains seven notes, most with two separate, parallel elements but the initial note is multiple-peaked (wavy), and its terminal note consists of a peak (one element) and, at a lower pitch, a horizontal second element extending like a dashed line on the sonagram (this last note also lacks the fundamental tone present in all other notes).

The frequency of the Pee Call notes at the dominant tone varies between 3.9 and 4.3 kilocycles for initial notes, between 3.7 and 4.0 kilocycles for median notes (of six calls), and between 3.4 and 3.7 kilocycles for terminal notes. The weaker fundamental tone correspondingly varies from about 2.1 to 1.7 kilocycles for initial to terminal notes. Most of the intense sound is contained within 0.4 kilocycles around the central frequency of the dominant tone for each note. The average drop in pitch from first to last note of six calls is 0.5 kilocycle. The duration of the notes is from 0.19 to 0.24 second, with little variation through the calls. There tends to be a diminishing intensity of the notes in a call—the last note is weaker than the first or second note in every call. I found no apparent difference between the two calls uttered in tandem with Pew Calls and the four calls given separately. The combined Pew-Pee Calls each lasted about 4.5 seconds. It is likely that the Pee Call will prove to represent a distant territorial proclamation—location call, and the Pew Call and Pew-Pee Call, a close-up, perhaps more aggressive call (delivered when a mate or potential antagonist has been seen or heard by the calling bird). The Pee Call of the Maroon Woodpecker is generally similar to the

simpler Pee Calls of the Bay Woodpecker; the tempo and general form of the (horizontal) notes are closely similar, as is the dropping pitch of notes throughout the call, but the Pee Call of the Maroon Woodpecker is higher pitched. Both the Pee Call of the Maroon Woodpecker and that of the Bay Woodpecker have the quality of the much more rapid, short-noted Long Call of *Celeus brachyurus*, which also diminishes in frequency as it progresses. There is also a resemblance of the Pee Calls of the two species of *Blythipicus* to longer-noted Long Calls of species of *Picus*, especially the Pee Call of *P. viridis*.

BAY WOODPECKER

Blythipicus pyrrhotis

The Bay Woodpecker ranges from the uplands of southern China, Hainan, and the Himalayan slopes of India and Nepal to Indochina, and highlands of Malaya. The Bay Woodpecker essentially replaces the Sundaland Maroon Woodpecker above 3500 feet in Malaya. I know of no place where these related species meet. Like the Maroon Woodpecker and the ecologically somewhat similar Okinawa Woodpecker (*Sapheopipo noguchii*), the Bay Woodpecker has a conspicuously pale (yellow) bill, and flicks its wings as it calls. In the highland forests the Bay Woodpecker forages much like the Maroon Woodpecker does at lower altitudes, except that it ventures up into middle levels of trees more often. Nevertheless, most foraging takes place within 3 or 4 meters of the ground, on moss-draped trunks, rotted stubs and fallen logs, saplings, and vines. When feeding higher up in the trees as it does about 30 percent of the time, the Bay Woodpecker stays near or on the trunk, virtually never moving out into view on an outer branch or in the foliage. At all times the species is wary—when disturbed it calls loudly and keeps in the shadows or behind a tree, out of sight of the intruder. I found it to be one of the most difficult of all woodpeckers to observe, due to these habits and the darkness of its understory habitat.

Pairs may forage in neighboring trees, but they freely separate and forage in different directions for long periods. After several hours or less of separation, and invariably in the evening they engage in calling bouts during which they converge (in most cases, the female moves toward the foraging and calling male). I saw no pairs foraging on the same tree or stub.

The modes of foraging are diverse for this woodpecker. Frequently it excavates well-rotted wood of stubs or fallen logs, tearing huge holes in them, apparently seeking grubs. When feeding other than by excavating in rotten wood, Bay Woodpeckers move frequently and rapidly, dropping to the base of a tree, foraging there and up its trunk a short distance, then dropping to another tree base or to a sapling again moving upward, probing, tapping, pausing for two or three hard blows with the bill, then moving on. At times they move very rapidly through the understory, bounding from a log to a sapling to snatch an insect, perching crosswise frequently, and often changing their direction of travel. At times one hears their tapping, but much excavating and tapping is in well-rotted, or at least wet wood, and hence they tend to make relatively little noise in feeding. On live trees they poke into crevices, probe epiphytes, and shake apart bits of moss to glean beneath it, as well as tapping and excavating occasionally. Berries and large beetle larvae are reported in the stomachs of Thai birds (Deignan, 1945).

The birds were in pairs during the course of my visits to Malaya and India, but I found no evidence for nesting. The species has not been reported nesting in Malaya, but it probably does so later in the year (after May).

No displays were observed, other than Crest-Raising of a calling male when a female called very close by, and Wing Flicking. The paired birds approached each other infrequently, and under conditions of poor visibility (dim light in the understory, fog, rain, etc.), such that I was unable to observe adequately the few apparent encounters. Wing Flicking occurred during Pit-Rattle Calls, and was exactly as in *B. rubiginosus*, which see.

I heard no drumming of either species of *Blythipicus*, and no mention of their drumming is made in the literature. It is important to verify the lack of drumming in these species during the pre-breeding period.

Vocalizations of the Bay Woodpecker generally are somewhat modified to highly modified versions of those of the Maroon Woodpecker. The Pit Call of the Maroon Woodpecker is represented by a longer version, the Peew Call, and by Pit notes rarely given alone, but initiating many Rattle Calls, hence the Pit-Rattle Call of the Bay Woodpecker. The full Rattle Call of the Bay Woodpecker is faster, and the sound of

individual notes is more diffuse than in *B. rubiginosus*. Both species have Rattle Calls with a wavering pitch. The Bay Woodpecker has a similar Pew Call to that of the Maroon Woodpecker, and a somewhat different Pee (Long) Call; as in the Maroon Woodpecker the Pew Call and Pee Call may be combined as a Pew-Pee Long Call.

The Pee Call of the Bay Woodpecker is a single (fig. 38b) note characterized by its length (0.10 to 0.35 second in duration), and by a very narrow range of pitch given in several tones. The strong fundamental tone is at 1.4 to 1.6 kilocycles, there is a nearly or quite as strong tone at 2.7 to 3.2 kilocycles, a moderately intense tone (sometimes codominant with the previous two tones) at 4.2 to 4.7 kilocycles, and weaker tones at about 6.2 and about 7.7 kilocycles. Most of the 10 examples analyzed have a vague to definite peak of an inverted U initially, followed by slightly less intense, diffuse (or forming irregular, "dashed" lines on sonagrams) sound at the same pitch. These calls are lower in pitch than the Pit Call of *B. rubiginosus*, but lowering the pitch of that species' Pit Call and removing emphasis on the "legs" of the inverted, U-shaped notes would result in a note essentially like a Pee Call note. I heard Pee Calls interspersed with Rattle Calls when two Bay Woodpeckers (pair) were together, but did not hear the Pee Call when I came upon a single bird (which uttered Rattle, or Pit-Rattle calls). The function of the call is unclear, and it may be a more aggressive form of the Pit Call.

Whereas the Maroon Woodpecker commonly uttered Pit Calls and infrequently gave a Rattle Call, I found that the Bay Woodpecker gave the Rattle or Pit-Rattle (fig. 38g, i, n) Call frequently, and less commonly uttered the Pee Call or a long "pit" note (last two are equivalent of Pit Call of Maroon Woodpecker). Notes of the Rattle Call basically are inverted, V-shaped notes with high peaks and diffuse sound almost or quite obscuring the peaks, with most sound included within 1 to 4 kilocycles. These notes are 0.02 to 0.03 second in duration. Several single "pit" notes, given between Rattle Calls, appear identical with the normal Rattle Call notes. The lead note of nine of 12 Rattle Calls analyzed, and certain notes within the Rattle Call differ markedly from normal notes in their greater length (0.035 to 0.045 second), in their sound attaining a higher pitch, and in the clarity of the

various tones. These "pit" notes show up to 11 distinct peaks on sonagrams at about 0.7, 1.4, 2.1, 2.8, 3.6, 4.3, 5.0, 5.8, 6.5, 7.3, and 8.0 kilocycles. The peaks are inverted, U-shaped with dominant tones usually including that at about 2.8 kilocycles, and often with codominant tones involving some or all of those at 1.4, 2.8, and 4.3 kilocycles. Other prominent tones frequently are those at 2.1, 3.6 and 8.0 kilocycles. Some of these notes lack the higher pitched overtones, and others only vaguely show, or fail to show the alternate tones at 0.7, 2.1, 3.6, and 5.0 kilocycles. Those notes lacking the alternate tones are very similar to the Pit Call of *B. rubiginosus*, but they lack the terminal tail of sound extending beyond the note, and they are slightly lower pitched.

Pit-Rattle and Rattle calls that were analyzable (12 calls) contained three to 26 notes, lasted 0.13 to 1.71 seconds, and were delivered at an average tempo of 15.2 (longest call) to 23 (shortest call) notes per second. None of the calls are regular throughout in tempo or in pitch. Rather there is one, or there are several peaks, usually a "pit" note, followed by rapidly uttered, then more slowly rendered notes diminishing gradually in pitch. The effect is that of a pulsating call, "dit-d-d-di-di-di—di-dit-d-d-di-di-di," etc., reminiscent of the slower call of *Reinwardtipicus validus*. The sharper pit or dit notes occur at intervals of four to eight notes, commencing always with the first note of a call. Each of these pit notes introduces a faster burst of notes, and each is preceded by slower ones. The greatest time between individual notes occurs just before, or from one to two notes before the pit notes.

The wavering Pit-Rattle and Rattle calls are given by disturbed birds and sound more intense when two birds are present. They seem exactly comparable with the Pit and Pit series calls of *Reinwardtipicus validus* and the Pit Call of *Blythipicus rubiginosus*.

The Pew Call is a series call of 10 to 14 notes (fig. 42d), which like the Pew Call of the Maroon Woodpecker sometimes is combined with the Pee Call into a combined Long Call. The Pew Call is uttered rather weakly, and I was able to secure only three analyzable calls. These lasted 2.12 to 2.97 seconds, delivered at a rate of 4.13 to 4.72 notes per second, thus about 40 percent slower than the notes of the Maroon Woodpecker's Pew Call. Individual notes are 0.08 to 0.15 second in duration. The dominant tone of the notes is the initial harmonic tone

peaking at 2.8 to 3.4 (one note at 3.7) kilocycles. The fundamental tone at 1.4 to 1.8 kilocycles is moderately strong. A note appears on a sonagram to consist of an initial peak (no, or almost no initial rise is present), a drop of 0.3 to 0.8 kilocycles, then a rise to the highest point in the note, followed shortly after some plateauing (some notes have a symmetrical, inverted, U-shaped second peak, others are flat topped at this peak or show a slight step before dropping) by a drop. A moderate to strong tail of sound carries beyond the second peak, in one call connecting peaks of adjacent notes. The notes drop slightly in pitch during a call, especially in the last two or three notes, and they shorten considerably (0.15 to 0.08 second in one case) to slightly (0.12 to 0.10 second in another case) during the calls.

Although lower-pitched and rendered more slowly, the Pew Call notes of the Bay Woodpecker resemble those of the Maroon Woodpecker. Notes of the call of both birds have an initial drop (preceded by a definite peak in *pyrrhotis*, whereas only the dropping leg is present in sonagrams of this call of *rubiginosus*) followed by a rise to the high peak of the call. The two species differ in that this peak drops off rapidly, then forms a clear step before the final drop in *rubiginosus*, and in *pyrrhotis* there is a plateau or very slight drop in a longer peak, followed by a full drop without (usually a few notes show this) a step. I was not able to establish clearly if a pair of birds were present every time I heard this call by the Bay Woodpecker, although two birds were present when one uttered the combination Pew-Pee Call that I recorded. Functionally, the Pew Call presumably is like the Pew Call of *rubiginosus*, which see.

Several combined Pew-Pee Calls were heard in Malaya, and one was recorded. The call was 5.07 seconds in duration, with an initial Pew Call of 2.64 seconds separated from a Pee Call of 2.23 seconds by 0.20 second, barely longer than the normal gap between notes of either call. The Pew Call portion of the combined call contained 11 notes, very slightly dropping in pitch and not changing in duration during the call. The notes are rather horizontal on sonagrams, with only a slight drop evident in the dominant tone (from 3.7 to 3.3 kilocycles). There is only a very slight rise, from 3.3 to 3.4 kilocycles, from the dominant tone of the last Pew Call note to that of the first Pee Call note. The two calls thus seem

structurally related, as well as perhaps overlapping in function. The combination call was uttered by one bird of a pair foraging together at Fraser's Hill.

The Pee Long Call (fig. 42g-j) is a variable series of nine to 13 notes delivered at a rate of 2.63 to 4.89 notes per second. Part of the variation in tempo may be geographical, for four analyzed calls from India (West Bengal) ranged from 2.63 to 3.07 notes per second, and calls of Malayan birds, from 3.33 to 4.89 notes per second. One call from India contained 11 notes delivered in 4.18 seconds, whereas an 11-note call from Malaya took 2.75 seconds. The form of the notes, although variable, differs in the same way in both regions, so that some sounded alike except for speed. Generally the notes increase in tempo during a call, but there is a diminishing intensity, pitch, and duration of the notes. The form of the notes ranges from a very broad, inverted U, either curved or flat-topped, and with a strong tail of sound extending beyond the peak, to an incomplete, inverted U with the rising portion and peak emphasized, but with additional tones receiving emphasis between major tones. The simpler of the former calls, with the emphasis on the peaks and tails, and notes descending in pitch, are very like the Pee Call of the Maroon Woodpecker, but are lower pitched.

The drop in pitch during a call averages 0.5 kilocycle in 10 calls (range of drop from first to last note 0.3 to 1.0 kilocycles) at the dominant tone. All calls show an increase in tempo of the notes throughout the call, corresponding with an average shortening of the notes by 0.1 second (terminal notes 0.06 to 0.17 second shorter than lead note). One of 11 calls shows no shift in intensity during the call, but all others and virtually every one of a hundred or so heard in the field diminished in intensity such that it was often difficult to hear the terminal note. In some calls the lessening of intensity was not very great, and in others there was an abrupt downward shift between the initial five or so notes and the last five or so notes, but in most calls the intensity diminished gradually, note by note. There was considerable variation in the intensity of various overtones, some calls having most of the sound contained in the dominant tone, and others emphasizing weakly or even moderately other overtones, in addition to the moderately intense fundamental tone (peak of fundamental

tone 1.4 to 1.75 kilocycles for lead notes, and 1.25 to 1.45 kilocycles for terminal notes).

The Pee Call is apparently the territorial call of the Bay Woodpecker, used also in making contact with a mate. The latter function probably relates to the tendency of the pairs to separate and feed some distance apart, and the very great carrying power of this call, which can be heard for a distance of about a kilometer or more. The loud "pee---pee---pee---pee---pee---pee---pee---pee---pee---a" is very much like the Pee Call of the Maroon Woodpecker, and some calls appear on sonagrams very similar indeed to that call. Usually the Pee Call of the Bay Woodpecker is lower pitched, and its sound varies more in pitch, being less clear-toned. Some Long Calls of *Celeus brachyurus* are somewhat like these Pee Calls (decrease in pitch, increased tempo, "pee" notes), but are much faster. Among other woodpeckers, some calls of species of *Picus* bear resemblance to the Pee calls of the Maroon and the Bay woodpeckers. I might mention especially the tailing Kwee Call notes of *Picus miniaceus*, and the Kweep Call of *Picus flavinucha*—the latter call having the additional tones interspersed about as in variant Pee Calls of *B. pyrrhotis* (the Kyew Call of *P. flavinucha* has an initial peak and also shows other resemblances to the Pew calls of the two species of *Blythipicus*). Finally, as in the case of *B. rubiginosus*, the Pee Call of *pyrrhotis* shows structural and functional similarity to the Pew Call (see Pew-Pee Call above).

ORANGE-BACKED WOODPECKER

Reinwardtipicus ("Chrysocolaptes") *validus*

The Orange-backed Woodpecker is a distinctive Sundaland species ranging to peninsular Thailand and Tenasserim in lowland primary forests, but extending into adjacent secondary forest and recently cut-over areas with standing dead trees. I particularly sought this species because W. Bock and I had concluded from an examination of its morphology that it was not congeneric with *Chrysocolaptes lucidus* and its relatives, as it has been treated universally. The observations discussed below strongly corroborate these earlier findings, and *Chrysocolaptes* as it presently stands clearly is polyphyletic. Hence *validus* is treated as the sole species of a monotypic genus, *Reinwardtipicus* Bonaparte, 1854.

The taxonomy of this species is discussed by Bock and Short elsewhere.

The Orange-backed Woodpecker is conspicuous because of its vocalizations and its excavating and tapping. It forages from the canopy to within a few centimeters of the ground, in sites as diverse as fallen tree trunks, vines as thin as 2 centimeters in diameter, and major branches of trees. Most often it is found in the middle and upper levels, on trunks, dead stubs, and large branches of trees. One pair foraged in several dead stubs amid the remains of a recently felled and burned forest fully one kilometer from the nearest standing forest. I am uncertain whether these were survivors of the destruction, foraging about their former territory, or opportunistic visitors from the neighboring forest. The former is likely for several reasons. It was dusk when I encountered the pair, and it seemed likely that the birds roosted among the dead trees in the burned area (I could not pursue them to check this out, but they did not fly far). Also, it seems likely that birds, including these woodpeckers, flee into surrounding areas, avoiding death in the holocaust, but perhaps are forced back into the burned area by aggressive action of conspecific birds already occupying territories in the adjacent forests. Virtually all Orange-backed Woodpeckers that I encountered were in pairs or in family parties, although the paired birds usually did not forage together in the same tree.

The major foraging modes are excavating and tapping. With their powerful blows these picids quickly open a small hole (up to 3 cm. in diameter) in the bark. Often they scale bark from dead branches and stubs, delivering blows at an acute angle, first from one side, then the other, until the small- to moderate-sized pieces of bark fall to the ground. Moving along a trunk, they progress rapidly, glancing from side to side, pausing here to deliver a few taps, and there to excavate a small cavity with a flurry of blows, and when reaching the smaller branches high in a tree, they fly to a nearby tree and begin again. Attention is paid to every stub or dead tree along the line of movement, and at such sites they whack off pieces of bark, or excavate, sometimes for minutes at a time, depending upon the condition of decay and available insects associated therewith.

Most of these woodpeckers seemed to have completed nesting prior to my arrival in Malaya

(February). I saw family parties of three birds (two instances) and four birds (two instances) in February, and in early March, but thereafter I encountered only pairs and a few apparently solitary birds. On February 14 I watched four birds for a half-hour as they noisily worked along a road in secondary forest adjacent to primary forest at Pasoh. Two young birds foraged to some extent on their own, but they followed the adults about, calling frequently, and from time to time they were successful in being fed large (possibly coleopterous) larvae by both male and female parents. The larvae (one at a time) were passed from bill to bill without regurgitation or the placing of the food deep within the mouths of the young birds. The adults foraged mainly by tapping several times in bark crevices, and they worked very low as well as at moderate (but not high) levels in the trees. One young bird followed the adult male to a large fallen tree, lying beside and projecting into the road. The male excavated several times, making three openings in the bark (the openings were the size of a quarter-dollar, and $\frac{1}{2}$ cm. deep). The young bird moved to the openings, one by one, as the adult left them, and there tapped and poked, obviously obtaining food. Two of the openings led into insect-bored holes under the bark, but I could find no insects after the birds left the log.

The displays I saw mainly included Crest Raising, seen whenever two birds (adults on two occasions, young and adults more than 20 times) approached each other closely, except that young birds seemed not to raise the crest to an adult. The male of a pair on a tall stub in a recently burned-over area reacted aggressively toward a pair of Dollarbirds (*Eurystomus orientalis*) that flew to the top of the stub. The supplanting attack of the Orange-backed Woodpecker, seen three times, involved a stretched body, raised crest, the head and bill pointing at, and stretched toward, the adversary, and a rush at the antagonist with fluttering, half-spread wings. In two cases, the female, which was lower down on the stub (farther from the Dollarbirds) followed the male, with crest partly raised and bill stretched out, but she did not spread the wings, and she halted well before the male. The male Orange-back supplanted the Dollarbirds in his first attempt and the Dollarbirds flew to a nearby stub, but one of them returned shortly thereafter and the woodpeckers moved back down the tree. After another round of supplant-

ings, the woodpeckers flew off, and left the stub to the Dollarbirds. Thus, Bill Directing, Wing Spreading, and Crest Raising are evidently agonistic displays of the Orange-backed Woodpecker. Wing Spreading was seen only in this encounter, Crest Raising was observed as noted above, and a few apparent incidents of Bill Directing (adult to young bird) were seen, but these were less marked than in the attack on the Dollarbirds. Wing Flicking was observed occasionally, but is not so frequent as in *Blythipicus pyrrhotis*, *B. rubiginosus*, and *Sapheopipo noguchii*. The Orange-backed Woodpecker seems to flick its wings in display only when very agitated. Three such displays were associated with Pit Flurry Calls, and another four occurred during long bursts of Pit Calls and Pit Series Calls (see below).

No drumming has been noted in the Orange-backed Woodpecker. Like the Maroon Woodpecker and the Bay Woodpecker, and in contrast to the Greater Goldenbacked Woodpecker drumming appears to be lacking, or if it occurs, it does so less often and over a more restricted period of time than in the Greater Goldenbacked Woodpecker.

Vocalizations of the Orange-backed Woodpecker most closely resemble those of *Blythipicus rubiginosus*, and consist of a simple elaboration of one basic, inverted U-shaped note in simplest form rendered as a Pit Call note. Lacking are the Keek Call, and the complex Kowk Call of *Chrysocolaptes lucidus*, and the Pee-Pew calls of species of *Blythipicus*. Some five or perhaps six calls of the Orange-backed Woodpecker were heard, and at least two analyzable examples of each were recorded on tape. The calls include the Pit Call, call notes and series of notes of juvenile birds resembling the Pit Call of adults, the Pit Series Call, and Pit Flurry Call, the Rattle Call, and a juvenile begging call resembling the adult Rattle Call.

The Pit Call (fig. 38d), is a single or double, fast, vertical note, forming an inverted U (longer) or inverted V (shorter). The fundamental tone varies from 1.3 to 1.4 kilocycles in pitch (27 examples), and the initial harmonic tone peaks at 2.5 to 3.7 kilocycles. Emphasis is on the fundamental tone (12 cases, usually at or near the peaks), the initial harmonic tone (eight cases, legs and peak emphasized), or both (seven instances). Other tones are very weak or absent. Notes vary in duration from 0.03 to 0.045

second. Three double Pit Calls are similar to single Pit notes, but show a distinct rise in pitch between the first and second note, very like that found in the characteristic terminal two notes of the Pit Series Call. The rise is from 1.6 to 1.8 kilocycles in one double call (fundamental tone), but from 1.3 to 2.0, and from 1.3 to 1.6 kilocycles in the other two calls. The first note is shorter than the second in all three cases. The calls last from 0.12 to 0.13 second, without the tail of sound continuing beyond their peaks. In one double call the fundamental tone is emphasized in both notes, whereas the initial harmonic tone is dominant in the first note and the fundamental tone emphasized in the second note of the other two calls. One double call (fig. 38d) is peculiar in having the first note peaked in a very tall, inverted V (peaks actually obscured, but very prolonged and tapering), and the second note a more typical inverted U. Pit Calls are uttered as occasional solitary calls, or in irregular series, apparently depending upon the degree to which the bird is disturbed. Pit Series Calls, expressing strong agitation (possibly aggression toward intruder), usually greet an intruder when it disturbs foraging Orange-backed Woodpeckers, and as the birds become accustomed to its presence (if they do not flee), the Pit Series gradually gives way to Pit Calls, which become fewer as foraging commences again. Pit Calls thus seem to be low-intensity agonistic notes. Pit notes resemble most closely the higher pitched Pit Call of the Maroon Woodpecker, but they have a less intense tail of sound following them.

Juvenile birds accompanying adults uttered two distinct calls. One of these seems to be an alarm-agonistic call, the equivalent of the Pit Call of adults. This call, a Di Call (fig. 39b), occurs as individual notes, in loose series, and in a trill. Notes of the call are vertical with diffuse sound over a range of pitch, especially between 1 and 3 kilocycles. They vary in duration from 0.015 to 0.04 second. Peaks are visible in sonagrams of notes in several calls. These occur at between 0.9 and 1.4 kilocycles, between 1.8 and 2.3 kilocycles, and, vaguely at about 3.0 kilocycles. Most notes show no distinct peaks, and diffuse sound is often concentrated about the initial portion of the note, that is on what appears to be the rising leg of the inverted V in the lower two harmonic tones. The notes sound like "di, di" or "da, da," and usually are less intense than

the Pit Call. Series of di notes, rendered "b-d-d-d-d-d-t" in my field notes apparently indicate greater alarm. Four such calls were analyzed, having five to 22 notes rendered variably at from 14 to 22 notes per second, and lasting 0.23 to 1.56 seconds. Apparently these are the equivalent of the Pit Series Call of the adults. Juvenile Di Calls resemble the Pit Call of *Gecinulus viridis* rather closely.

The Pit Series Call (fig. 38e, f) is usually elicited initially by an intruder disrupting foraging of a pair or party of Orange-backed Woodpeckers. It is characterized by a slow series of rather regularly uttered pit notes, terminated by a rapid double pit, with a step-up in pitch. The terminal double note is much like the (higher pitched) double Pit Call of *Blythipicus rubiginosus*, and the calls would be confusing except for their occurrence in a series in *R. validus*, and as a simple, double pit in *B. rubiginosus* (double Pit Calls of *R. validus* sometimes are uttered apart from the Pit Series Call, as noted above, and then they may be confused with double Pit Calls of the sympatric *B. rubiginosus*). In both of these woodpeckers, then, a double pit is characteristic, punctuating a loose, irregular group of pit notes in *B. rubiginosus*, but ritualized to terminate a regular series of pit notes in *R. validus*. Eleven examples of the Pit Series Call contained six to 13 notes, averaging 8.73 notes per call. Calls lasted 0.84 to 2.10 seconds (average 1.37 seconds), and the tempo of the pit notes excluding the final double note varied from 5.2 to 6.8 notes per second (average 6.18 per second). Individual notes vary from 0.035 to 0.06 second in duration with the terminal note (second of the double-noted portion) always the longest note of a call. The terminal double note averaged 0.129 second in duration, with variation only between 0.12 and 0.15 second.

Emphasis in the Pit Series Call is placed on the initial harmonic tone, usually peaking at about 2.9 kilocycles (2.2 to 3.4 kilocycles, except terminal note), and to a lesser extent on the fundamental tone at 1.1 to 1.7 (usually 1.3 to 1.5) kilocycles. In one of 11 calls the fundamental tone was dominant to the initial harmonic tone. The initial note of a call may be faint, and very low pitched, distinctly different from the other pit notes of a call. Most calls show a rise in pitch of their notes, but not exceeding 0.4 kilocycles in the dominant tone. In more than half the calls the penultimate note

(initial note of the terminal double note) is distinctly higher pitched (five cases) or lower pitched (two cases) than the preceding note. The terminal note averages 1.23 kilocycles higher in pitch (0.7 to 1.7 kilocycles) than the note preceding it, with the initial harmonic tone peaking between 4.0 and 4.7 kilocycles. The fundamental tone, peaking at 2.0 to 2.3 kilocycles is stronger in this terminal note than in other notes of the calls, and in eight of 11 cases it is the dominant tone, in contrast to other notes. There is an especially strong tail of sound extending beyond the terminal note at its two major peaks. The Pit Series Call is an intense alarm and agonistic call. In addition to my eliciting the call when I disturbed the birds, this call often was uttered when one bird (e.g., a juvenile coming to beg for food) suddenly approached another—the latter bird called.

The Pit Flurry Call (fig. 38h) apparently is a functionally somewhat different version of the Pit Series Call. Seven calls were available for analysis. One of these was uttered by a woodpecker in flight. Three were accompanied by Wing Flicking. The call consists of a rapid series (invariably at 12 to 12.5 notes per second) of notes identical to the terminal note of Pit Series Calls, preceded by a lower pitched pit note in the same way that that terminal note is so preceded. Unlike the Pit Series Call, the Pit Flurry Call contains no introductory series of pit notes. Usually it is uttered amid an irregular group of Pit Calls but without any pattern. In two instances there are no prior pit notes, except of course the introductory, low-pitched note included as part of the call. The seven Pit Flurry Calls contained three to five high-pitched notes plus, in each case, a lower pitched introductory note. Although regular in tempo the notes are pitched irregularly, with a high point reached on the second note in some cases, the center note in other cases, or in steps up to the terminal note in other instances. Variation among the (higher pitched) notes of the calls is from 0.3 to 0.7 kilocycles in the initial harmonic tone (at 2.9 to 4.6 kilocycles). There is also variation in dominant tones, with the fundamental tone dominant or codominant with the initial harmonic tone in the terminal note of the calls, but the initial harmonic tone dominant in some of the earlier notes of some calls. Only one of seven calls shows no variation in intensity of these tones among its notes. The Pit Flurry Call seems to be an

agonistic call, perhaps showing a greater tendency to flee than the Pit and Pit Series calls.

The Rattle Call (fig. 38o) of the Orange-backed Woodpecker was heard infrequently, and was recorded satisfactorily only twice. The calls are long series of inverted, U-shaped notes delivered at the rate of about 16 notes (15.9, 16.1 in two examples) per second. Characteristic are the shortness of the notes (duration 0.02 to 0.035 second), emphasis on the peaks of the fundamental tone and first harmonic tone, and the rising portion of the latter tone, and a slightly rising pitch through the call. One call of 21 notes delivered in 1.32 seconds emphasized the initial harmonic tone peaking at 1.7 kilocycles in the initial note, at 2.2 kilocycles in the second note, rising to 2.7 kilocycles at the ninth note, and thereafter shifting to 2.9 kilocycles by the terminal note. The fundamental tone peaks correspondingly at from 0.8 to 1.5 kilocycles. The other call contains 27 notes uttered in 1.68 seconds, and strongly emphasizes only the peak of the fundamental tone at 1.2 kilocycles initially, rising to 1.4 kilocycles by the eighth note, and thereafter rising gradually only to 1.5 kilocycles terminally. The weak initial harmonic tone peaks correspondingly at 2.4 to 2.9 kilocycles. The notes are similar in form throughout both calls, and there is no change in tempo or other irregularity in the calls. The Rattle Call of *R. validus* differs from those of *Blythipicus rubiginosus* and *B. pyrrhotis* in that the notes are essentially identical to its call notes (Pit Call), whereas Rattle Calls of *rubiginosus* and *pyrrhotis* contain notes quite unlike their call notes. Rattle Call notes of *R. validus* lack the emphasis on overtones shown by the higher-pitched Rattle Call of *B. rubiginosus*, and they are not like the vertical, diffuse notes of the Rattle Call of *B. pyrrhotis*. The Orange-backed Woodpeckers gave the Rattle Call sporadically in apparent conflict situations, that is, when a male flew to a tree occupied by a female, the male gave this call. It is interpreted as an agonistic call emphasizing the aggressive tendency.

The Begging Call (fig. 38m) of juvenile Orange-backed Woodpeckers is equivalent to the Rattle Call of adults. The notes of the Begging Call are less regular, and there is more variation among calls than was found in the small sample of adult Rattle Calls. Some calls essentially are like Rattle Calls, but are slower and with more variation among notes within a call.

Other calls show moderate emphasis on higher pitched overtones, unlike the Rattle Call. Six analyzable calls contained eight to 25 notes, rendered at rates of 10.1 to 14.3 notes per second. The calls were 0.57 to 2.27 seconds in duration, but others I heard were almost continuous for up to 5 seconds. The fundamental tone is dominant in five calls, with peaks at 1.4 to 1.7 kilocycles, and the initial harmonic tone is strong or dominant (one case) at 2.3 to 3.2 kilocycles. Different tones are evident at 4.0 to 4.5 and at 5.4 to 6.0 kilocycles in two calls (vaguely in one other). The notes tend to be asymmetrical, with the rising leg emphasized over the dropping, terminal leg. The duration of the notes varies from 0.025 to 0.035 second in most cases, but irregularly distributed, higher pitched notes tend to be longer (0.03 to 0.05 second). Longer bursts of Begging Calls increase in intensity toward their conclusion.

Begging Calls were uttered by juvenile birds actively following adults in February, and the calls were more intense when the young birds were in proximity to adults. An occasional Pit Series response of adults to young birds employing a Begging Call suppressed the latter call, implying aggression by the adult and perhaps some agonistic tendency in the Begging Call. It seems likely that the Rattle Call progressively develops from the Begging Call, and this may be reflected in the variation among Begging Calls analyzed.

The Orange-backed Woodpecker appears not to drum, and seems to lack calls resembling the Keek Call, and the Kowk Flight Call of *Chrysocolaptes lucidus*. Other vocal differences between these species include: the wavering quality, lower pitch, and emphasized overtones of the Rattle Call of *Chrysocolaptes lucidus* compared with the Rattle Call of *Reinwardtipicus validus* and generally, the greater variability in vocalizations of *Chrysocolaptes lucidus*. The simpler vocal repertory of *R. validus*, including the Rattle Call similar to its call note (Pit Call), is much more similar to the repertoires of *Blythipicus rubiginosus* and *B. pyrrhotis*, despite their having a Pew-Pee Call, which is apparently lacking in *R. validus*. Particularly significant are the similarities in Pit Calls, the Wing Flicking coupled with pitlike calls, the apparent lack of drumming, and the absence of complex flight calls in *Reinwardtipicus validus*, *Blythipicus rubiginosus*, and *B. pyrrhotis*, contrasted with *Chrysocolaptes lucidus*. *Dinopium*

javanense is vocally more like *Chrysocolaptes lucidus* than are the other species just mentioned. Further studies are necessary to establish conclusively the relationship of *Reinwardtipicus validus* with *Blythipicus*, but pending completion of such investigations, it is clear that *R. validus* is not closely related to *Chrysocolaptes (lucidus)*, and that it should be separated from *Chrysocolaptes* tentatively as a monotypic genus for which *Reinwardtipicus* is the available name.

BUFF-RUMPED WOODPECKER

Meiglyptes tristis

Buff-rumped Woodpeckers are scattered about lowland primary forests of Malaya, but they are most common at forest edges, about clearings or areas of second-growth within forests, and in second-growth. This Sundaland species, which reaches peninsular Thailand and Tenasserim, forages in saplings and smaller trees, and especially in the branchlets and ends of branches of tall forest trees. Foraging is almost entirely done by rapid gleaning, with occasional probing, often at the tips and leaflets of tiny branchlets. The birds move rapidly, and fly several trees away from one site to another. Their dark eye is conspicuous against an almost white face as they move about. While feeding, they frequently hop about perching crosswise, or hang upside down. The flight of this species seems direct, like that of a passerine bird, or *Jynx*. I heard no tapping during the time when the birds foraged, although I saw them tap rarely. Their food seems mainly to be ants gleaned from the surface of the bark or leaves. Birds forage singly, or, occasionally, in pairs, as when they join a mixed foraging flock.

I observed nest construction from April 9 to April 14 at Kuala Lompat. The birds excavated a hole 8 meters up a live tree broken off at 12 meters above ground. Its diameter was about 17 centimeters. At the time that I discovered the excavation, the birds had constructed the opening and were working fully inside the cavity. Sessions of excavating lasted 15 minutes to an hour and 10 minutes, with the sexes sharing equally in the excavation. On April 10 there was no activity about the nest until 9:00 A.M., when both flew in giving low (Wicka Call, see below) calls. The female left abruptly, and the male worked inside for 15 minutes, when the calling (Wicka Call) female replaced him. After more

than an hour (10:20 A.M.), the male replaced the female, and continued excavation until 11:30, when, in another Wicka-calling ceremony, the female again took over. The only display observed was slight head-swinging, accompanying the Wicka Call. A peculiar feature is the discarding of wood chips, not by simply tossing them out of the opening of the cavity as do most woodpeckers, but by the birds fully backing out of the opening, then tossing the chips (my presence may have caused this behavior, as, occasionally they did throw chips in the normal manner). Unfortunately I could not follow the course of events beyond April 14. Chasen (1939, p. 179) described a nest containing two eggs in a stump of a tree 7 feet tall in Negeri Sembilan on March 21; he also mentioned a nest in Borneo with a clutch of two eggs.

Drumming is weak by this woodpecker. One stub regularly used for drumming was 20 meters up a live tree. Drumming sites seem to be used every day early in the morning during March and April. As in *Meiglyptes tukki*, there are drumming bouts between the members of a pair, but these are less prevalent and of shorter duration. The low intensity taps are delivered at a rate of 12 to 17 beats per second (fig. 36d). Short drumming bursts are given more rapidly, and long bursts have a rapid initial phase (15 to 17 notes per second) and a slower (12 to 14 notes per second) terminal phase. Ten recorded drums lasted 1.4 to 3.0 seconds, and contained 18 to 44 individual beats.

Four different vocalizations of *Meiglyptes tristis* that I heard are the Pit Call, the Pee Call, the Trill or Rattle Call, and the Wicka Call. The Pit Call (fig. 36e) is a soft, mechanical, either single or double note with a dominant fundamental tone at 2.8 kilocycles, and a somewhat weaker tone at 5.6 kilocycles. This call is a simple, inverted V-shaped (or narrow U-shaped), note with a duration of 0.03 second for single notes, and 0.05 second for double notes. The latter tend to be lower in pitch (fundamental at 2.4 kilocycles), and their second note has a less intense harmonic at 4.8 kilocycles than the first note (the fundamental tone at 2.4 kilocycles receives the most emphasis in both, however). These calls were emitted by a pair of the birds when I first found their excavation site (see above), but I did not hear them otherwise. It is my impression that Buff-rumped Woodpeckers, unlike many woodpeckers, silently fly away from

an intruder rather than challenging him with calls; hence the (small-sized) birds are inconspicuous and one must find a nesting site to hear their vocalizations. The weak Pit Call is extremely similar to the Pit Call of *Hemicircus concretus*, which see. A burst of Pee Calls, the only ones that I heard, was uttered by one of the pair at the nest site. This call, resembling in form the longer Peew Call of *Hemicircus concretus*, appears to be a more intense alarm or anxiety call than the Pit Call. The Pee Call is in the form of a peaked, inverted U-shaped note, which then either tapers downward in pitch or remains horizontal. The notes are 0.15 to 0.20 second in duration, peaking at 2.2 to 2.8 kilocycles; they rise rapidly to the peak, then drop gradually to about 1.8 kilocycles, or remain plateaued at 2.0 or 2.2 kilocycles.

The Wicka Call was not recorded. The Wicka and equivalent calls are widespread in woodpeckers (Short, 1970, 1971a, 1971b, 1972), and usually are uttered softly by birds interacting together—hence they are infrequently heard and rarely tape-recorded. The Wicka Call of *Meiglyptes tristis*, rendered in my notes as “very *Colaptes*-like ‘wicka, wicka, wicka,’ ” and “wick-a, wick-a, wick-a” on two different occasions, was heard only at the site of excavation when the male and female met as one replaced the other at excavating. Wicka Calls generally are variable, agonistic calls that also serve a pair maintenance function, and I believe this to be true of this call in *Meiglyptes tristis*.

Many, usually distant Trill Calls were heard, but I only recorded one suitable (fig. 39c) for sonagram analysis. This trill is the equivalent of Rattle Calls of other woodpeckers (Short, 1971b). The call resembles the more rattle-sounding Trill Call of *Meiglyptes tukki*, but is higher pitched (virtually no overlap in pitch of the intense, emphasized tone at about 4.8 kilocycles) and the notes are shorter and uttered more rapidly. A call of 1.62 seconds in duration contained 30 notes, thus at a rate of 18.4 notes per second. Other Trill Calls, both shorter (less than one second) and longer (over two seconds) were heard, and were similar to that figured (fig. 39c). There is a wavering tendency in the calls caused by a slight rise in pitch, usually in the middle of each call. Notes of the call that I analyzed show an even level of 4.7 kilocycles for the most intense portion of all notes, but the middle notes, and to a lesser extent the terminal

notes, have moderately intense elements between 4.8 and 5.2 kilocycles and these are lacking in the initial seven notes of the trill. These remarks refer to the apparent first harmonic tone; the very faint fundamental tone is at about 2.6 kilocycles. Each note is an inverted V-shaped note 0.02 to 0.025 second in duration. The bases of the inverted-V notes extend only very weakly below 4.0 kilocycles; virtually all the sound is pitched at between 4.0 and 5.5 kilocycles. The function of the Trill Call probably is allied with that of drumming, that is, it is an agonistic, territory-proclaiming call with perhaps a contact-maintaining function between members of a pair. This was the only call heard away from the site of excavation. It is rendered in my field notes as a "soft rattle-'drrrrrrr.'"

BUFF-NECKED WOODPECKER

Meiglyptes tukki

The Buff-necked Woodpecker is a lowland Sundaland species extending north into peninsular Thailand and Tenasserim. Larger than its sympatric relative *Meiglyptes tristis*, it frequents areas with a dense understory, both in primary forest and in tall secondary forest. It is less frequently found at the edges of forests than is *tristis*, and it seems not to be attracted to clearings. Where both occur together, *tristis* is at the forest edges and scattered about near openings, trails, and clearings within the forest, whereas *tukki* is widespread within the forest, especially where there are undergrowth and rotting stumps. Its foraging sites include the leaves, buds, and branch tips of tall trees where *tristis* forages, but it more frequently covers the trunks and larger branches, and additionally, it spends much time in rotted stubs, logs, and in bushes and saplings of the understory. Overall, then, it forages in more diverse sites than does *tristis*.

Foraging modes of *tukki* are like those of *tristis*. There is very little tapping, and much surface gleaning, some probing and a little prying of dead wood. On trunks or large branches Buff-necked Woodpeckers frequent the broken places, or cracks in the bark. A pair feeding together at a low, rotted stump hopped about, pecking and poke-pecking into the rotten wood, displacing pieces of it, and making no noise. One female was observed from a tree platform (elevation 115 feet above ground) for 15 minutes as it foraged briefly in one spot, moving about very

little, then flew several trees away, and repeated its brief foraging. It probed and pecked about leaves and buds in the topmost branches of the tallest forest trees, but spent little time in any one tree (30 seconds per site, less than one minute per tree). It also probed about in a crevice in one tree trunk. At the time of my study (March, April), pairs frequently foraged together, especially when foraging in the undergrowth. At rotten stubs both fed side by side, moved about the stub together, but when foraging in saplings or vines, the birds used different sites 2 to 5 meters apart. Several individuals participated in mixed species foraging flocks, to the movements of which their rapid foraging modes seem well suited. Their food apparently consists mainly of ants and termites (Smythies, 1960).

I do not know of any descriptions of nesting of this species, and I was unable to locate a nest. David Labang of the University of Malaya discovered a bird excavating a cavity at Pasoh, Negeri Sembilan on February 28, but the entrance of the cavity had been enlarged and broken, and the site abandoned by the woodpeckers when I visited there on March 7. The cavity was 1½ meters above the ground in a well-rotted stub about 2½ meters high. The bark barely was clinging to the very rotten wood, and the excavated cavity, 20 centimeters deep by 12 centimeters wide, abutted against the thin, loose bark.

I observed Head-Swinging Displays accompanying vocalizations in an encounter between two males. The head-swinging was partial, involving two or three swings, as one male paused in chasing the other. Calls during this encounter included a Long Call, a "dwit-wit-wit" series, a double "twit-twit," a moderately fast Trill Call, and a typical, fast ("soft, non-*Picoides*-like") trill "dididididit."

As in *Meiglyptes tristis*, the drumming of *Meiglyptes tukki* is rather weak, that is, the blows are not strong and resonance is low. Drumming bouts lasted from less than one to more than three seconds. Drumming that I recorded (fig. 36c) ranged in duration from 0.89 to 3.02 seconds. The beats occurred at rates averaging from 13.7 to 19.5 per second. The longer drumming episodes are characterized by a slow-down of about one-quarter in the rate of delivery of beats, e.g., from 16 to 12, 20 to 15, 22 to 17, beats per second between the initial and the terminal portions of the drumming. Shorter

drumming bursts are rapid, about like the initial portion of a longer burst. The drumming generally is equally intense throughout a burst, or there is a lessening of intensity at the end of a burst. In at least three cases, however, the beats varied in intensity. One burst of 48 beats contained three weaker sections involving eight to 10 beats interspersed through the burst. A shorter burst (34 beats) has two weak segments of a few beats initially, and two like segments terminally, with an intense central portion. Finally, one short burst (16 beats) has a weak initial section of four beats, and a single weak central beat. Whether these represent functional variants, or are the result of some form of external disturbance (e.g., sudden movements of a nearby animal), is unclear. Drumming bouts between mates early in the morning occurred regularly during March and April. In one instance a male drummed twice a minute for 10 minutes from a stub broken 6 meters up a small tree, and a female responded in like fashion, drumming between the bursts made by the male, from 3 meters up a large, partly decayed stump situated 25 meters away from her mate. Such bouts suggest that drumming in *tukki* serves not only territorial and location functions, but somehow functions in helping to synchronize the reproductive physiology of the pair.

Call notes were not recorded, and indeed I heard these only during the interaction between two males, mentioned above. The "dwit" and "twit" notes given as double notes or in short series resembled the Pit Call of *Meiglyptes tristis*, and also had a quality reminiscent of that of the Dwot Call of *Mulleripicus pulverulentus*. They probably are low intensity agonistic calls, but this remains to be demonstrated.

A foraging female that I disturbed gave two "pee" notes, not recorded, that sounded like the Pee Call of *Meiglyptes tristis*, and thus it is documented that this call occurs in both species. Nothing can be said of its function.

A call that I shall term the Long Call was heard several times during an encounter between two male Buff-necked Woodpeckers, and I recorded two such calls (fig. 39d). These vocalizations, rendered "wick-wick-wick-wick--," are structurally and perhaps functionally akin to the Long Call of flickers (*Colaptes* especially *auratus* and *atricollis*; see Short, 1972). The longer of the two calls that I recorded was 1.82 seconds in duration, containing 18 notes

evenly spaced at 0.06 to 0.07 second apart except for the first two which were slightly farther apart. Each note is an inverted U-shaped note 0.03 second in duration, emphasized at 2.3 kilocycles, and slightly less so at 4.6 kilocycles. Other tones are very weak. There is an initial rise to a peak, which is the intense part of the note, and then a symmetrical drop (fundamental rising from 1.5 to 2.3 kilocycles, dropping back to 1.5 kilocycles) which is slightly more intense than is the rise. The shorter call was 0.83 second in duration, and contained six notes, the first of which was slightly apart from the others. These notes were spaced at 0.07 to 0.11 second apart, and were identical to those of the longer call except for being slightly lower (2.25 kilocycles) pitched and shorter (0.03 second versus 0.04 second) notes. The call differed from the longer call chiefly in its slower rate (7.2 notes per second versus 9.9 notes per second for the longer call). The study of the relation of this call to the Trill Call would be enlightening, as both seem to be agonistic in function (both used by chasing male, see above).

The Trill Call of *Meiglyptes tukki* resembles that of *Meiglyptes tristis*, but is longer, slower, and lower-pitched (fig. 39c). I heard no short versions of this call, and all of those recorded are more than 1.75 seconds in duration (few trills of *tristis* were as long as the shortest calls of *tukki*). Ten Trill Calls averaged 2.24 seconds in duration (range 1.93 to 2.89 seconds), and contained an average of 34.6 notes per call (range 28 to 43 notes). There is a slowdown in the rate of notes during the call, but it is less pronounced than in *tristis* (e.g., from 17 to 16, 17 to 14.5, 17 to 14 notes per second in the initial versus terminal portions of calls of *tukki*). As in *tristis*, it is not the fundamental tone but the next harmonic above it that is dominant but the fundamental tone receives some emphasis at the peaks, unlike that of *tristis*. The fundamental tone is at 1.4 to 1.9 kilocycles, and the more intense next higher tone varies from 2.8 to 3.8 kilocycles, which is completely below the lower limit (4.0 kilocycles) of intense sound in the trill of *tristis*. Within a given call, there may be essentially no variation in pitch among the notes (half the calls recorded), slight variation, or considerable variation. The variation when it occurs involves a lower-pitched initial phase of one to six or even 10 notes, and then a higher-pitched, longer terminal phase. Each note is

0.03 second in duration, inverted U-shaped, exactly symmetrical in form and intensity, and it rises to a very intense peak (at 3.0 to 3.8 kilocycles) before dropping off. The frequency with which I heard this, the most commonly uttered call, suggests that it serves a primary location function. Members of a pair emit this call, and respond to it when emitted at a great distance, whereas drumming bouts between members of a pair occur when the birds are in proximity to one another. Of course other functions, such as agonistic behavior (use of this call in a male-male chase), may be served as well.

GRAY AND BUFF WOODPECKER

Hemicircus concretus

This compact but tiny woodpecker was one of the most interesting picids that I encountered. A Sundaland species, it extends north in the lowlands to Tenasserim and peninsular Thailand, occurring in primary and secondary forest. Like *Meiglyptes tristis* it is a fast-moving, treetop bird, spending much time in clusters of leaflets and on tiny branchlets, and often clinging upside down. However, it also frequently forages over the trunks and branches, especially high in trees. It seems to prefer trees standing above others in the forest, taller trees in second-growth woods, and isolated trees beyond the edge of the forest. Once one becomes acquainted with its weak but characteristic calls, it is seen frequently, calling, as it flies over the forest or across clearings from one feeding site to another. Once it alights in the crown of a tree, it disappears in the foliage, and only with the greatest effort can one follow its progress; fortunately it moves rapidly, reappearing sporadically. It calls irregularly, more so than do species of *Meiglyptes*, thus attracting attention to it.

When foraging in isolated trees, Gray and Buff Woodpeckers may spend as much as 20 minutes or more rapidly moving from trunk to branch to branchlet throughout the tree. Frequently, they alternate foraging in leaf clusters with feeding on a trunk or dead branch. Usually they are solitary, but pairs occasionally forage in the same tree. On one such occasion a male alternately foraged for 15 minutes on the trunk or large branches and in the foliage, while the female confined her activities to the smallest branchlets. Females foraging alone usually mixed their foraging sites about as much as

males, but, during several long (10 to 15 minute) episodes lone females foraged entirely on branchlets less than 2 centimeters in diameter. In contrast, I never saw a male so confine its activities, although I observed more males than females.

Their foraging movements are very rapid, and involve much tangential hopping, clambering, backing downward, twisting, hanging upside down and leaning far to the side. Of all the true woodpeckers I have observed, this species came closest to making frontal movements downward on a trunk, although the move was slightly tangential. Their progress up a straight trunk is very erratic because of their backing, sidling, tangential moves, and darting to the side. They pivot from side to side and turn their heads, tit-like, under leaves and leaf clusters, and they may hang upside down for a minute or more at a time. Very frequently, perhaps as frequently as not, they perch horizontally on small branches and branchlets.

Foraging modes include gleaning, tapping, probing, and prying. Not only does *Hemicircus concretus* tap more than *Meiglyptes tukki* or *tristis*, but its taps frequently can be heard nearby. Nevertheless they do glean more than they tap; peering, twisting, darting, and hanging, they pick off insects (possibly ants), probing for the insects if they are hidden between leaflets or in bark crevices. When pairs foraged together I noted that females tap more softly than males, and perhaps they tap less often too. The large crests of these woodpeckers were partly raised much of the time, such that, unlike *Meiglyptes*, the sexes could be distinguished readily at a distance (I might add that their small size, big-headed appearance due to the crest, short tail, and the very different ventral and head colors rendered Gray and Buff Woodpeckers easily distinguishable from Buff-rumped Woodpeckers).

The frequent vocalizations, crest raising, and sporadic conflicts suggest that this species is pugnacious, or that territoriality and pair formation were under way at the time of my studies. Unfortunately the birds move so rapidly that, notwithstanding their conspicuousness, they are difficult to observe, and I noted only a few fragmentary displays other than Crest Raising. During intersexual encounters the crests of both birds are raised, this occurring more often in the male. As usual in woodpeckers, males were completely dominant, supplanting the females while foraging, and in many cases

driving them away when they approached calling males. Several times an approaching female uttered a Trill Call. On one occasion a "kyew"-calling male attracted a female, which flew toward him giving a Trill Call. His crest was elevated fully, his calls changed to a higher-pitched "kyow," he directed his bill at the female, leaning toward her, and then with a half trill-rattle ("ki-di-di-dit") he flew at her, supplanted her, then gave chase, calling "kit-kit-kit." Chases were noted frequently, sometimes involving two males, and other times a male and female (I saw no female-female encounters or chases).

Nothing is known of the nesting of the Gray and Buff Woodpecker. Chasen (1939, p. 183) mentioned an account of two birds encountered, each in a separate hole among a series of four holes atop a 30-foot dead stub in Selangor, Malaya, during July. On April 17, 1972, I spied three birds, including a male and two apparent females (neither was an adult male, but at the distance and angle of observation I could not distinguish immatures from females) at the top of a 30-meter dead tree. The male was excavating inside the topmost of four small holes situated in a series, one above the other. The two females perched (quietly?) nearby. The male exited from the cavity, and then, perched at the entrance, he drummed, very faintly, three times. After six minutes, the two females flew off. The male returned to excavating, briefly and from the outside, and after three minutes he too flew away. Whether nesting was under way I could not determine. Series of four or more holes, at least two of which are used by different individuals simultaneously are known only for *Hemicircus concretus* and *Chrysocolaptes lucidus*. If the situation in *Hemicircus concretus* proves to be like that of *Chrysocolaptes lucidus*, the four holes would represent a nesting cavity plus three roosting holes, accounting for either a pair and two young (if the old nesting cavity is used for roosting) or a pair and one young bird (old nesting cavity not used for roosting).

Only one incident of drumming was detected, that being the drumming male at the cavity mentioned above. Drumming is apt to be infrequent if it is always weakly delivered as in this single instance.

Because of their low intensity, calls were not adequately recorded often, but I did manage to obtain a few examples of three different calls for

spectrographic analysis. These are the Pit Call, the Peew Call, and the Trill or Rattle Call. They essentially represent all the types of calls that I heard, although many variations were not recorded. For example, the longer "tsip" and "tseep" variations of the Pit Call were not recorded. The Pit Call (fig. 36f) is an inverted V-shaped (or narrow U-shaped) note of 0.03 second duration with its greatest intensity at the peak of the fundamental tone (usually 3.3 kilocycles, but varies from 2.8 to 3.4 kilocycles). Moderately intense is the rise of the next higher tone between 4.0 and 5.5 kilocycles, and somewhat less intense are the rise of the fundamental tone (around 2.2 kilocycles) and the peak of the apparent first harmonic (6.6 kilocycles). The notes are symmetrical, but with greater intensity on the rising than on the falling portion. Most of the sound is between 2 and 7 kilocycles. This call is almost identical to the Pit Call of *Meiglyptes tristis* (fig. 36e), from which it differs only in its slightly higher pitch (2.8 to 3.4 kilocycles versus 2.4 to 2.8 kilocycles for peak of fundamental tone), and in being louder. These notes vary somewhat in *Hemicircus concretus*, with renderings from my notes as follows: "pit," "tsip," and "tseep." The last seems to be given only in flight, especially during chases, and it very likely is an intense version of the Pit Call, serving an agonistic function. Unfortunately, as noted above I have no recorded "tseep" notes and am unable to analyze them.

The Peew Call (fig. 36g) of *Hemicircus concretus* is a complex call commencing with a typical Pit Call note, which, instead of dropping fully, swings upward at from 1.8 to 2.1 kilocycles (fundamental tone; the upswing of the more intense, higher tone commences at from 3.5 to 4.2 kilocycles) to a peak not quite so high as that of the initial pit element, that is to 2.6 or 2.8 kilocycles in the fundamental tone (or 5.5 or 5.6 kilocycles in dominant tone). Following this peak, there is an irregular faster (more vertical) or slower (more horizontal) drop, occasionally with plateaus. From the end of the initial pit (0.03 second in duration), the terminal "eew" element varies in length from 0.3 second with no plateaus to 0.45 second with plateaus at 1.7 and 1.0 kilocycles (for the fundamental tone). The full note thus varies from 0.33 to 0.48 second in duration. Other characteristics of the Peew Call are the prominence of the apparent first harmonic tone, which is slightly more

intense than the fundamental (other harmonics are weak), and the progressively steeper slope (more vertical) of the harmonic tones of the "eeew" element. For example, in one call the fundamental drops from the initial peak of the eew element at 2.8 to 1.8 kilocycles (a 1.0 kilocycle drop), the next higher, dominant tone falls from 2.8 to 1.8 kilocycles (a 2.8 kilocycles drop), and a still higher tone drops from 8.4 to 3.6 kilocycles (a 4.8 kilocycles fall). The Peew Call closely resembles the Kweek Call of *Celeus brachyurus*, from which it differs in reversely falling rather than rising; it also is longer and higher pitched, and has a more prominent pit element. The Peew Call is associated closely with the Crest Raising Display, and seems to be an intense agonistic note. It was especially prevalent during encounters, and when I intruded too closely upon a foraging bird. I did not obtain recordings of the most intense and longer version, a "Kee-yew," which seems to lack a pit element or to have that element very weakly developed.

I recorded a slow, series of notes emitted by a female of *Hemicircus concretus*, rendered "ti-ti-tee-tee----ti." Unfortunately the recorded call is rather weak, and I am unable to discern all its features. Basically it is a series of 13 "tee" notes delivered in 1.4 seconds, the notes being inverted U-shaped, with emphasis mainly on the peak, but with an additional element at a higher pitch at the end of each note. The fundamental tone, about as intense as the next higher tone, peaks at 2.3 kilocycles (the higher tone peaks at 4.6 kilocycles), and the additional element is at 3.3 kilocycles. Each note is 0.08 second in duration with the additional element occurring in the terminal 0.03 to 0.05 second. The notes are spaced equally, and are alike except for the initial and terminal two notes, which are slightly lower in pitch and lack the additional element of the other notes. I cannot comment on the possible function of this "Long Call" or its equivalent.

The Trill Call of *Hemicircus concretus* (fig. 39e) closely resembles that of *Meiglyptes tristis*. The only recorded trill is 1.32 seconds in duration, and contains 25 notes, each about 0.25 second in duration. The peaks of the inverted V-shaped notes are between 2.5 and 3.0 kilocycles for the fundamental tone and between 4.5 and 6.0 for the much more intense next higher tone. The notes are more irregularly pitched than in *Meiglyptes tristis*, although terminal notes are

higher pitched generally than are initial notes. Thus there is a more wavering quality of the trill of *Hemicircus concretus*. Other minor differences from *Meiglyptes tristis* include the more sharply peaked notes, the slightly greater prominence of the fundamental tone and the apparent second harmonic tone (although both are weak in contrast to the dominant first harmonic tone), and, most notably, an intense, "dragging" element extending slightly beyond each note at 4.6 kilocycles, evident in wide band spectrographic analysis. The Trill Call is used during chases, and it appears to be an agonistic call. Notes of this call are essentially lower pitched, Pit Call notes, although the first harmonic tone is more strongly emphasized in the Trill Call notes than in the Pit Call. Series of "pit" notes, not recorded, graded into the Trill Call, and it is evident that these calls are structurally and probably functionally related, just as are the Peek and Rattle calls of *Picoides* (various species; Short, 1971b).

HEART-SPOTTED WOODPECKER

Hemicircus canente

I glimpsed a male of this species, and heard it call several times at Sukna, West Bengal in early May. There, in sal forest, the male foraged rapidly up the trunk of a tree gleaning and tapping as it proceeded. Higher up the tree a pair of *Picoides macei* foraged, paying no attention to the male of *Hemicircus canente*. Suddenly the latter flew off calling "ch-yew" several times. This call seemed nearly identical with the Peew Call of *Hemicircus concretus*, which *canente* replaces in forests from India to Thailand, Annam, and Cambodia. No other individuals were seen.

GREAT SLATY WOODPECKER

Mulleripicus pulverulentus

Figure 43

This large, widely distributed woodpecker is most unusual in appearance and behavior. Ranging from India to South China and Borneo, it occupies lowland primary forest and cut-over areas with scattered standing tall trees. Many authors have mentioned its social habits, but most of these reports probably reflect observations of family parties. Prior to breeding the birds occur regularly in pairs—indeed I saw lone



FIG. 43. Male Great Slaty Woodpecker (*Mulleripicus pulverulentus*) at site of nest excavation, Kuala Lompat, Pahang, Malaya. Note degree to which head is turned, and long bill.

birds only three times during my studies. Their size and noisy behavior call attention to them, and since families of such a large species are apt to remain together for a long time, it is not unexpected that these family groups are very conspicuous. This is by far the heaviest woodpecker in Southeast Asia, for Malayan specimens outweigh those of *Dryocopus javensis* by two to one (400 to 465 grams versus 225 grams).

In addition to their large size these woodpeckers (fig. 43) appear ungainly because of their long thin neck and heavy body, long bill, noisy (rustling wings) flight, and the apparent difficulty they seem to have in propelling themselves upward—almost in “slow motion”—on tree trunks. They also perch crosswise on smaller branches, and bound about clumsily, as if emulating a small passerine bird, but with a decidedly ungraceful effect.

Foraging occurs in favored big trees, in many cases far from other foraging sites, and the wood-

peckers often are heard calling as they wing their way over the forest. They cross open areas to visit lone, standing trees, and they also forage occasionally in small trees to within 3 meters of the ground. They seem to cover a vast area, and their territories must be much more extensive than those of *Dryocopus javensis*. When foraging on trunks, they hop upward with seeming difficulty, spiraling about the tree, backing up frequently, and pausing at crevices and other breaks in the bark. In the upper branches they may bound about, perching crosswise as they move from branch to branch. Usually they do not cover the entire tree, but only part of the trunk and one or two major branches. Once a pair foraging high in a tree dropped into the understory, and I was surprised to find them hopping and half-flying from sapling to sapling picking off insects (possibly ants). Pairs forage together nearly all the time, although not usually side by side. Occasionally they make their way

up a large trunk together, but usually the male precedes the female by several meters or more, and frequently they move upward on opposite sides of the trunk. Invariably they proceed to select different branches for foraging when they reach the upper part of a tree, and if one is unsuccessful in locating food, it may fly to an adjacent tree and forage there, calling frequently, thus maintaining contact with its mate. When one departs the area, the other follows, usually giving the Whinny Call (see below).

The foraging modes of this woodpecker include gleaning, probing, tapping, prying, and excavating, in that order. On large branches and trunks Great Slaty Woodpeckers glean and poke in every depression, crack, and cranny, tapping now and then, and occasionally pausing to excavate briefly; when excavating, its blows are powerful and are delivered from a head position far to the rear. Usually the tapping or excavating is not sustained, and the bird moves on. In smaller branches or in saplings, the woodpeckers glean, and they reach widely with their long bill, head, and neck darting to one side or the other. Ants and termites comprise most of their food (Deignan, 1945; Smythies, 1960; specimen labels I have seen indicate ants only).

An episode was instructive regarding roosting behavior of the Great Slaty Woodpecker. During early March, I had noted a male White-bellied Black Woodpecker (*Dryocopus javensis*) roosting nightly in a cavity of a stub 20 meters tall and $1\frac{1}{2}$ meters in diameter. At the top of the stub far above the roosting cavity of *javensis* was an opening (very old woodpecker hole) leading into a large cavity, rotted out and exposed fully at the top. At 6:40 P.M. on March 8, some 20 minutes before dark, I heard the nearby drum of *Dryocopus javensis*, but in the roost tree itself, tapping gently, was a male *Mulleripicus pulverulentus*. At that moment a female of the latter species flew in and perched below the male who clambered up to the top of the stub, then entered the opening leading into the exposed cavity. The female flew away, but the male remained in the cavity with his head jutting out of the opening, sporadically calling (Whinny Call). At 6:50 P.M. a male *Dryocopus* flew in, perched low on the stub, then climbed rapidly to the top, to within a meter of the opening from which the *Mulleripicus* male peered forth. There were no calls, but the *Dryocopus* male apparently perceived the *Mulleripicus* male, and it departed from the stub, flying west.

Immediately thereafter, as darkness fell, I heard four series of drumming bursts of *Dryocopus javensis* from the direction in which the male of that species had flown. At this point I could no longer discern the openings in the tree. At day-break (6:45 A.M.) on March 9, the male *Mulleripicus pulverulentus* moved out of his roosting cavity and called twice. His mate appeared almost instantly from the west, and then both flew off to forage. That evening I returned to the stub, and found the pair of *Mulleripicus* near it at 5:45 P.M. Apparently disturbed by my appearance, they flew away. At 6:40 P.M. both Great Slaty Woodpeckers returned, calling, and perched in the stub. The female then left, the male called twice, and entered the same cavity he had occupied the previous night. From within the cavity he called sporadically until 6:50 P.M. This incident indicates a displacement of *Dryocopus javensis* by *Mulleripicus pulverulentus* at the roosting tree, and it demonstrates that, despite their sociality, mated Great Slaty Woodpeckers roost separately.

During March and April at Kuala Lompat, a pair of *Mulleripicus* excavated consecutively two cavities that I believe were destined to be nesting cavities. Unfortunately neither attempt succeeded. From March 4 to 6 excavation took place 25 meters up a very large tree at a point above a swollen, cracked, and broken enlargement (2 meters in diameter on a 1-meter thick trunk), such that the cavity excavated would penetrate into the swollen area. The male worked from 9:30 A.M. to 10:15 A.M. on March 4, and the female, foraging nearby, then replaced him and excavated for 20 minutes. During the replacement, I heard "ta-whit" notes and other low notes (see below). The female flew off at 10:35 A.M. On March 5 the male worked from 2:12 to 3:15 P.M. (not in morning), when the female replaced him, uttering muted notes. I waited until 11:00 A.M. on March 6 at the site, but no birds appeared and I had to depart from the region.

When I returned to Kuala Lompat on April 5, I found that the cavity excavated earlier by the pair of *Mulleripicus pulverulentus* had been taken over by a large, orange-rufous mammal of some type (perhaps a monkey or a squirrel). However, on April 7 I located a male excavating a cavity 150 meters away from the earlier one. The tree utilized was a giant, fully 3 meters in diameter and 60 meters tall; the cavity was being excavated 45 meters up at the base of a dead stub,

on the underside. The female foraged, tapping lightly in a nearby tree. The male labored from 9:30 A.M. until at least 11:30 A.M., and when I returned at 2:30 P.M., he was still excavating. At 3:50 P.M. no bird was at the cavity, but at 6:00 P.M. he was back, excavating again. On the morning of April 8 both male and female took turns excavating for short periods, but at 11:00 A.M. the male, with its body nearly all the way in the cavity, turned and fled "yelping" as a Black Hornbill (*Anthracoceros malayanus*) flew laboriously to the entrance of the cavity, supplanting the woodpecker. Although the hornbill paused there only briefly and was not seen again near the cavity, regular checking failed to turn up the woodpeckers at that site in the next several days.

According to Chasen (1939, p. 185), the Great Slaty Woodpecker nests in July and August in Malaya, laying two or more eggs in a cavity as high as 30 feet up. However, Smythies (1960) noted that the woodpecker nests in April in Burma. The fact that both male and female excavated at the cavities that I found suggests that these were being constructed as nests. The lack of success in early nesting may account for the relatively late nesting reported by Chasen, who also mentioned that one pair, after excavating a cavity, eventually nested in an older cavity (they possibly were displaced from the original hole) that had been used by other birds. Thus, they do not necessarily require a new cavity yearly, and it is possible that cavities excavated and lost to other birds or mammals are used by the woodpeckers in subsequent years.

I watched the excavating woodpeckers for many hours, and noted their movements in addition to obtaining photographs and moving pictures. When excavating, this woodpecker spreads its feet wide apart, leans far backward (tail closely appressed to the trunk, and curving against it), holds its head far backward in a tight S-curve, and then thrusts with great power. On withdrawal of the bill, I note from photographs that the bill is usually open. The blows are well-spaced, so that the process of excavation is rather slow. The working bird pauses frequently to call, or more often to scan the sky and trees—it does this by raising its head almost vertically and twisting the neck to an incredible 180 degrees. Incidentally, a slight crest is evident in most of my photographs, although this has not been shown in most paintings or drawings of *Mulleri-*

picus pulverulentus in various publications. Females participate in the excavation, but to a lesser extent than do males.

Visual displays were not evident generally, although I spied a few Head-Swinging Displays of a curious type occasionally when members of a pair were together. The Head-Swinging is unusual in that the long neck gives the swing a comical effect since the head tends to "drag" behind the body in swinging. I was able to elicit a bout of displays by playing back several Whinny Calls when two birds foraged nearby on April 12. The birds responded to the playbacks by flying into a tall tree overhead. There they chased each other, usually with the male chasing the female, calling a fast, short Whinny Call. The pursuits were marked by an Anhinga-like spreading of the wings, which were held half out as the birds bounded from branch to branch and along the branches. As they gave this Wing Spreading Display I saw continuous Tail Spreading, and Head and Body Swinging. Their long necks (that of the male tinged red, and male with red malar stripes also conspicuous in that region during displays) made their movements comical, almost hornbill-like, as they hopped and clambered about, frequently perching crosswise even on large branches. The wings were held in a spread or partly spread position throughout their interaction. Following this, both birds preened for 20 minutes (they do preen a great deal, and pairs often spend 45 minutes or an hour preening atop a dead tree just after sunrise).

I did not hear drumming of this woodpecker, and diverse literature references to its instrumental sounds are unclear as to whether the reports treat drumming signals, sounds of tapping and excavating, or both. My failure to hear this woodpecker drumming in the course of three months when nest cavities were being constructed, and the prevalence of Whinny Calls suggest that the latter calls may largely or completely replace drumming functionally. If so, the lack of drumming by this woodpecker might serve to avoid competition (e.g., at roost holes) with the loud and frequently drumming *Dryocopus javensis*.

Several fluttering sounds caused by the wings of Great Slaty Woodpeckers were recorded. The sounds produced somewhat resemble that of a flying hornbill, the wing flapping being slower and louder than that of other picids.

I recorded examples of four major groups of

vocalizations, all that I heard except for sporadic Dit Calls ("di-di-dit-dit" or "dit, dit") and a Rattle Call variation ("dididididi") of the Dit Call heard but twice. Two commonly heard vocalizations are the Dwot Call, and the Whinny Call including its variants, and two less commonly heard calls are the low Mewing Call and the Wicka Call.

Dwot Call notes (fig. 36i) are single notes, sometimes uttered in loose series, and generally about 0.13 second (0.10 to 0.15 second) in duration. Typical notes commence with a flat or slightly downward curving element at 0.8 to 1.0 kilocycles, lasting 0.05 to 0.09 second, then rising gently or steeply to a peak at 1.3 to 1.5 kilocycles. These data are for the fundamental tone, slightly weaker than the next higher harmonic tone, which peaks at 2.8 or 3.0 kilocycles. There is a terminal vertical element, often separated from the curved, rising initial element, but coinciding temporally with the peak at the end of that element. Its intensity is greatest at 1.8 to 2.0 kilocycles, giving a more sharply peaked effect to the end of the note. The most intense parts of the note are the terminal element of the fundamental tone, and the entire next higher tone; the initial element of the fundamental tone is slightly weaker, and other harmonic tones are very weak.

One variant Dwot Call is the Low Dwot Call, having a concave initial element with a very low terminal peak (1.0 or 1.1 kilocycles in the fundamental tone). This call note lacks the terminal, vertical element of the typical Dwot Call, and it tends to be longer in duration.

Another variant of the Dwot Call is the introductory flight note, which is higher pitched, has emphasis almost entirely on the fundamental tone rather than on any harmonic tone, and lacks a terminal vertical element. Its initial curving element is at 1.3 or 1.4 kilocycles, and it rises at its end to 2.2 to 2.8 kilocycles.

Flight Dwot Call notes resemble typical Dwot Call notes, and they have a terminal vertical element, but they (fig. 36i) are shorter (0.10 to 0.12 second). They also have an additional dropping element that falls from 2.0 or 1.5 kilocycles to 1.0 kilocycle in 0.02 second or less, then joins the abbreviated (only 0.03 to 0.04 second duration) element corresponding to the full initial element of a typical Dwot Call.

Dwot Calls serve various functions, one being that of a location note. They also seem to be an

alarm call, indicating the presence of an intruder or a disturbance nearby. The Flight Dwot Call and its introductory note may stimulate the other member of the pair to join in flight, and perhaps other aspects of synchronization may be involved.

Mewing Calls (fig. 36h) are low notes that may represent long, flattened Dwot Call notes. These "conversational" notes were uttered by members of a pair together at a site of excavation and are written in my journal as "pek," "mew" and "pew." They also were given by a lone bird at the "nest" in response to a nearby Whinny Call by its mate, and sporadic calls by a lone bird on several occasions prompted a Whinny Call in response. One form of the Mewing Call is a long (0.3 to 0.48 second) note, wavering slightly from convex to concave in the center to convex at the end, all between 0.7 to 0.8 kilocycle (fundamental tone). As in the Dwot Call, the initial harmonic tone at 1.5 or 1.6 kilocycles equals or exceeds in intensity the fundamental tone. It is this version that prompted and followed Whinny Calls.

A shorter version of the Mewing Call (fig. 36h) has two convex portions often broken or nearly broken in the center of the call, which is 0.20 to 0.32 second in duration. The distinguishing feature of this form of the call is that the initial harmonic tone (at 1.4 to 1.6 kilocycles) is strongly emphasized, and the fundamental tone is very weak like the other harmonic tones. This version is the low "pew" call heard from members of a pair perched beside one another.

A vocalization tentatively designated the Wicka Call, and described as "dew-it, dew-it" notes in my field journal, is a 0.3 second broad, U-shaped note. It shows a fast (0.03 second) drop from between 1.2 and 1.5 kilocycles to 0.6 kilocycles, followed by a concave portion 0.12 to 0.13 second in duration, often with a raised (0.7 kilocycle) point in its center, then a fast rise (in 0.05 second) to a peak at 1.6 to 2.0 kilocycles, followed lastly by a variably long (up to 0.1 second) plateau. The note has weak harmonics, and the fundamental tone is most intense at the initial and terminal peaks. The call was emitted by one of two birds performing a brief Head Swinging Display, and it appears to serve agonistically as do Wicka Calls in other woodpeckers (Short, 1971b, 1972).

The somewhat variable Whinny Call carries farthest, is uttered frequently, and is the most

often heard call of the Great Slaty Woodpecker. A typical Whinny Call (fig. 36j, k) contains two to five notes, although four is the usual number. The notes are rather evenly pitched, generally within 0.2 kilocycle, but occasionally varying within 0.5 kilocycle in pitch. The call has a strong fundamental tone between 1.2 and 2.0 kilocycles, a weak initial harmonic tone, and much weaker higher harmonic tones. The initial note often is slightly higher pitched, and it usually is symmetrically inverted U-shaped. The middle notes are about equal in pitch, or they barely drop consecutively, and are skewed with a peak late in the note and a step in the rising initial portion. The final note often is distinctly lower in pitch (by 0.1 to 0.4 kilocycle), and it frequently is delayed slightly and not evenly spaced with the others. Notes are given at a rate of 11 to 15 per second; with two-to-five-note calls respectively lasting 0.17 second ($N=1$), 0.26 second ($N=4$), 0.38 second ($N=13$), and 0.46 second ($N=6$).

Very like the typical Whinny Call is the Short Whinny Call (fig. 36m) of two or three notes. This call has a strong fundamental tone and weak harmonic tones like the Whinny Call, but the notes are connected with one another, and they rise and fall to a greater extent. The connected notes show a drop of as much as one kilocycle between notes, and frequently there is a plateau at the base of the drop between notes. The two notes of the two-note call and first two notes of the three-note call are about equal in pitch (2.0 or 2.2 kilocycles), but the terminal note of a three-note call drops as much as 0.4 kilocycle. The call is delivered at the same

rate as Whinny Calls of comparable length.

More divergent and variable is the Dropping Whinny Call (fig. 36l), of which I recorded four examples. All contained four notes. The duration of the calls was 0.24 to 0.27 second (rate 15.4 notes per second), showing no overlap with four-noted Whinny Calls. The notes usually drop consecutively, and rather sharply in pitch from between 2.0 and 3.0 kilocycles to between 0.9 and 1.3 kilocycles from the first to the last note. Characteristic of all these calls was the strong initial harmonic tone, which equaled the fundamental tone in intensity. The call commences on a high and often long peak of an inverted U-shaped note that lacks an initial rising portion. This note drops to the second note, which, like the third note is skewed strongly toward the end of the note. The terminal note resembles the middle two notes in its skewness, but it is lower in pitch (0.1 to 0.7 kilocycle below third note) and often is less intense; unlike the terminal note of the typical Whinny Call, this note shows no spacing apart from the other notes. A single variant call is more horizontal, but is fast and has the first note peaked much above the other notes; because of the peaking of this note and its strong initial harmonic tone it is categorized as a Dropping Whinny Call. This variant call immediately followed a regular Dropping Whinny Call (fig. 36l) given during the displays of a pair of birds described above. The Dropping Whinny Call seems to be a more intense form of the Whinny Call, but their exact relationship, and that of the Short Whinny Call to them, remain to be investigated.

DISCUSSION

IT IS TEMPTING to draw on data just presented and those from my report (Short, 1970) on Argentine and Peruvian woodpeckers to compare ecologically and distributionally the southern Asian and South American woodpeckers. I refrain from so doing because various geographic, systematic, and other considerations would render a broad comparison of relatively little value (a more limited comparison of lowland forest woodpeckers will be presented elsewhere). Likewise, behavioral and systematic implications of the above data are more appropriately treated elsewhere in the framework of a consideration of all the woodpeckers of the world. The discussion herein will be limited to certain aspects of woodpecker ecology and diversity in southern Asia.

Table 1 lists the various Asian woodpeckers I have studied and their size, habitat, and (summarized) foraging modes. Most species fall within the Small and Medium size categories. The 18 species (including two in the Medium to Large category) in these two categories represent no fewer than nine genera, and half are species of *Picus*. As many as three species of *Picus* (*miniaceus*, *puniceus*, *mentalis* in lowland Malaya; *canus*, *vittatus*, and *flavinucha* in peninsular Thailand) may occur sympatrically. In these cases the sympatric species show different foraging modes, or they differ in the sites in which they forage. In other cases involving two congeneric species that are sympatric, there is a distinct size difference. Examples are of Little *Picoides cathpharius* and Small *P. darjellensis* near Darjeeling, and of Little *Meiglyptes tristis* and Small *M. tukki* in Malaya. Within *Picoides*, Little *moluccensis* and *canicapillus* are sympatric in coastal Malaya, and Little *canicapillus* and *macei* are sympatric in the Himalayan foothills, but the latter species is in each case larger, although still within the same size category. Otherwise, congeneric species generally are allopatric, as in similarly sized *Picus puniceus*-*P. chlorolophus*, *P. mentalis*-*P. flavinucha*, *Dinopium javanense*-*D. rafflesii*, *Blythipicus rubiginosus*-*B. pyrrhotis*, and *Hemicircus concretus*-*H. canente*.

Other interesting points may be made concerning size comparisons. Where Little and Small species of *Meiglyptes* occur together with

Little *Hemicircus concretus*, species of (usually Little) *Picoides* are not sympatric. This is not simply a distributional matter of chance, for well-marked species of *Picoides* occur beyond the range of these species of *Meiglyptes* and *Hemicircus* both eastward (Celebes, Philippines) and northward (continental Asia), as well as on the fringes of their Sundaland range (i.e., coastal *P. moluccensis* and *P. canicapillus*). The strongly gleaning habits of *Meiglyptes*, and the mixed tapping and gleaning habits of *Hemicircus* and *Picoides* may limit the number of these similarly sized species that occur sympatrically.

With the great number of picid genera in southern Asia, it is noteworthy that very few species attain truly large size. The only Large southern Asian woodpecker is *Dryocopus javensis*, representing a genus whose members also attain Large size in the Palearctic and New World. *Mulleripicus pulverulentus*, the only Very Large species in southern Asia, represents a genus endemic to that region; the Philippine and Celebes species of *Mulleripicus* are considerably smaller than *pulverulentus*.

About half of the species observed forage for ants frequently if not entirely. These include especially *Celeus brachyurus*, species of *Picus*, species of *Dinopium*, and species of *Meiglyptes*. Almost all of these ant-foraging woodpeckers are of Small (one Little) to Medium size, thus in great part accounting for the preponderance of species in those categories. No primarily ant-gleaning woodpecker attains Large size, which is true also in the New World, Europe, and Africa. No fully terrestrial, ant-foraging woodpecker has evolved in southern Asia, as has occurred in Africa and South America; conditions favoring the evolution of such a species are more localized and have perhaps changed too frequently for it to have occurred.

A major factor in the evolution of diverse Asian woodpeckers has been the repeated Pleistocene separation and junction of Sundaland with the Asian continent. Speciation patterns reflecting such actions are evident in allospecies of at least six superspecies, namely (Sundaland species first): *Sasia abnormis-ochracea*, *Picus puniceus-chlorolophus*, *Picus mentalis-flavinucha*, *Blythipicus rubiginosus-pyrrhotis*, *Meiglyptes*

TABLE 1
SIZE, HABITATS, FORAGING MODES OF WOODPECKERS STUDIED^a

Species	Size ^b	Habitat	Foraging Mode
<i>Picumnus innominatus</i>	Tiny	Upland forest, bamboo	Tapping, gleaning
<i>Sasia abnormis</i>	Tiny	Lowland forest, bamboo	Tapping, gleaning
<i>Picoides moluccensis</i>	Little	Lowland edges, mangroves	Gleaning, probing, tapping
<i>Picoides canicapillus</i>	Little	Lowland second growth, edges	Gleaning, probing, tapping
<i>Picoides macei</i>	Little	Lowland open woods	Gleaning, tapping
<i>Picoides cathpharius</i>	Little	Montane oak-rhododendron	Tapping, gleaning, excavating
<i>Picoides darjellensis</i>	Small	Montane oak-rhododendron	Tapping, gleaning, excavating
<i>Celeus brachyurus</i>	Small (to Medium)	Lowland forest, scrub, edge	Gleaning, probing, tapping
<i>Dryocopus javensis</i>	Large	Lowland forest	Tapping, excavating
<i>Picus miniaceus</i>	Small-Medium	Lowland forest	Gleaning, probing, tapping
<i>Picus puniceus</i>	Small-Medium	Lowland forest	Tapping, gleaning, probing
<i>Picus chlorolophus</i>	Small	Upland forest	Tapping, gleaning, probing
<i>Picus mentalis</i>	Small-Medium	Lowland forest	Probing, gleaning, tapping
<i>Picus flavinucha</i>	Medium-Large	Upland forest (M)	Probing, gleaning, tapping
<i>Picus vittatus-viridanus</i>	Medium	Mangroves, scrub	Gleaning, tapping; ground also
<i>Picus squamatus</i>	Medium-Large	Montane edges	?; partly on ground
<i>Picus canus</i>	Medium	Upland forest (M)	Ground; also tapping, gleaning
<i>Dinopium rafflesii</i>	Medium	Lowland wet forest	Gleaning, tapping
<i>Dinopium javanense</i>	Small (to Medium)	Edges, scrub, mangroves	Gleaning, probing (tapping)
<i>Chrysocolaptes lucidus</i>	Medium (to Large)	Lowland edges, woodlands	Excavating, and tapping
<i>Gecinulus viridis</i>	(Small to Medium)	Bamboo, lowlands and slopes	Gleaning, tapping, probing
<i>Blythipicus rubiginosus</i>	Small-Medium	Lowland forest	Tapping, excavating, probing
<i>Blythipicus pyrrhotis</i>	Medium	Upland forest	Tapping, excavating, glean- ing, probing
<i>Reinwardtipicus validus</i>	Medium	Lowland forest	Tapping, excavating
<i>Meiglyptes tristis</i>	Little	Lowland forest, edges	Gleaning, probing
<i>Meiglyptes tukki</i>	Small	Lowland forest	Gleaning, probing, (tapping)
<i>Hemicircus concretus</i>	Little	Lowland forest, edges	Gleaning, tapping, probing
<i>Hemicircus canente</i>	Little	Woodlands, lowland forest	Gleaning, tapping, probing
<i>Mulleripicus pulverulentus</i>	Very large	Lowland forest, edges	Gleaning, probing, tapping

^aThese are summarized; see text for details.

^bBased on approximate average weight (see Short, 1970, table 2), as follows: Tiny – to 15 grams, Little – 16–45 grams, Small – 46–95 grams, Medium – 96–175 grams, Large – 176–275 grams, and Very Large – over 275 grams. Weights are not known for a few of the above species; weight is then surmised from wing length data.

Symbol: (M), Malaya.

tukki-jugularis, and *Hemicircus concretus-canente*. These species pairs either involve birds of the same size or the continental (northern) allo-species is larger (namely *Picus flavinucha*, *Blythipicus pyrrhotis*, *Hemicircus canente*). In three of the six cases the northern, continental allospecies has evolved a preference for montane slopes or hills, and is montane in Malaya (*Picus chlorolophus*, *P. flavinucha*, *Blythipicus pyrrhotis*). Other species may have evolved in isolation much earlier in

Sundaland, leaving no continental relatives (*Reinwardtipicus validus*, unless ancestral *Blythipicus* was its continental allospecies), or distant relatives (*Dinopium rafflesii*) there. Other super-species or subspecies groups show zones of contact or approximate one another in range farther north, and cannot be considered strictly Sundaland-continental in pattern. These involve *Gecinulus viridis-grantia* and the *vittatus* and *viridanus* groups of *Picus vittatus*.

The various data presented are in accord with the views presented earlier (Short, 1970) that similarly sized woodpeckers either are allopatric, or if sympatric, they differ considerably

in foraging habits. Sympatric woodpeckers differ in size or in foraging habits (and associated bill structure), or both.

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