colchicine is effective in the treatment of about three-quarters of all attacks of gout without significant rebound after cessation of therapy (*16*), although other modes of therapy, such as adrenocorticotrophic hormone, may be followed by recurrent attacks.

The availability of a specific and sensitive method for the measurement of colchicine, not requiring the administration of a radioisotope, should lead to important clinical uses. Whether plasma and urinary concentrations are different in gouty patients on colchicine prophylaxis who have recurrent attacks as opposed to those who do not is not yet known. Our method should be helpful in monitoring patient compliance. Finally, since colchicine is under study in clinical situations apart from its use in acute gout—for example, in hereditary Mediterranean fever (*17*) and in hepatic cirrhosis—a method for the study of the clinical pharmacology of this agent should assume increasing practical importance.

NORMAN H. ERTEL
JAMES C. MITTLER, SUAT AKGUN
Departments of Medicine and *Endocrinology, Veterans Administration Hospital, East Orange, New Jersey 07019,* and *CMDNJ-New Jersey Medical School, Newark 07103*
STANLEY L. WALLACE
Department of Medicine, Jewish Hospital and Medical Center, Brooklyn, New York 11238

References and Notes

1. W. Mikkelson, in *Current Therapy*, H. F. Conn, Ed. (Saunders, Philadelphia, 1973), pp. 397–399.
2. S. L. Wallace, *Arthritis Rheum.* **15**, 317 (1972).
3. T. F. Yu and A. B. Gutman, *Ann. Intern. Med.* **55**, 179 (1961).
4. S. L. Wallace, B. Omokoku, N. H. Ertel, *Am. J. Med.* **48**, 443 (1970); S. L. Wallace and N. H. Ertel, *Metabolism* **22**, 749 (1973).
5. N. H. Ertel and S. L. Wallace, *Biochem. Med.* **4**, 181 (1970).
6. J. C. Mittler, N. H. Ertel, S. Akgun, S. L. Wallace, *Clin. Res.* **23**, 222 (1975).
7. S. L. Wallace and N. H. Ertel, *Bull. Rheum. Dis.* **20**, 582 (1969).
8. B. F. Erlanger, F. Borek, S. M. Beiser, S. Lieberman, *J. Biol. Chem.* **228**, 713 (1957).
9. D. W. Donigian and R. J. Owellen, *Biochem. Pharmacol.* **22**, 2113 (1973).
10. N. H. Ertel and S. L. Wallace, in preparation.
11. A. Goldstein, L. Aranow, S. M. Kalman, *Principles of Drug Action* (Harper & Row, New York, 1968), p. 130.
12. C. Boudene, F. Duprey, C. Bouhuon, *Biochem. J.* **151**, 413 (1975).
13. N. H. Ertel and S. L. Wallace, *Clin. Res.* **19**, 348 (1971).
14. T. W. Smith and E. Haber, *N. Engl. J. Med.* **289**, 1063 (1973); J. E. Doherty, W. H. Perkins, M. C. Wilson, *Am. J. Med.* **37**, 536 (1964).
15. S. Cohen and J. R. Johnson, *Dis. Chest* **38**, 30 (1960).
16. S. L. Wallace, D. Bernstein, H. Diamond, *J. Am. Med. Assoc.* **199**, 525 (1967).
17. S. E. Goldfinger, *N. Engl. J. Med.* **287**, 1302 (1972).
18. Supported by Veterans Administration research grant MRIS 2491. Reprint request should be addressed to Dr. Norman H. Ertel, Medical Service, VA Hospital, East Orange, N.J. 07019.

19 February 1976; revised 12 April 1976

Gibbons and Their Territorial Songs

Abstract. *Discovery of the great call of the Javan gibbon and finding an enclave of the agile gibbon in Kalimantan permit for the first time a comparison of vocalizations among all major taxa of* Hylobates. *The songs are stereotyped, constant throughout the interrupted areas of distribution of each taxon, and are sexually divocal.*

Recently we succeeded in tape-recording wild populations of the rare silver gibbon of Java, whose unique territorial song has not previously been described. This was during our travels in Southeast Asia to hear all species of gibbons in the natural state in order to compare their vocalizations. We believe such criteria (*1*) might solve the problem of how many species make up the genus *Hylobates* of man's fourth closest relatives. We also discovered throughout the genus that the male's and female's contributions to the territorial song are entirely different, that these songs are stereotyped, and that they are consistent throughout the entire range of each species, even those whose distribution is interrupted by intrusions of another species. Further, we found that the familiar vocalizations of the agile gibbon, hitherto known only from western Malaysia and Sumatra, also prevail over a large section of central Kalimantan as well as in extreme southern Thailand; at the latter place, south of Yala, we had earlier misidentified their songs (*2*). We tape-recorded in the wild all the isolated populations of gibbons (there is a total of 14 such populations variously separated by rivers and straits) except those of the concolor gibbon, which we could not find in the portions of its range we visited, in Laos. Also, we did not observe the populations of siamangs and lar gibbons in western Malaysia, whence excellent recordings were already available.

Audiospectrograms of the territorial songs of gibbons, which we label as if they are all species of equal rank, are displayed in Fig. 1. We have incorporated a few recordings, superior to ours, from colleagues as indicated. A glance at Fig. 1, each line of which reads like a musical staff, shows that the scores are so long and complex (some involving polyphony) that they deserve a more detailed description, which we will offer after introducing the manner and time of delivery and apparent function of the territorial song.

Each pair of gibbons daily advertises its territory by loud singing accompanied by gymnastics—a show of force. The female's great call dominates the half-hour morning bout. It is a brilliant theme lasting 20 seconds or more, repeated every 2 to 5 minutes. It swells in volume after soft opening notes, achieves a climax in pitch, intensity, or rapidity (at which time the gymnastics occur), then subsides. The male's shorter phrases, varying according to the species, either appear at appointed times during the great call, follow it as a coda, are interspersed between great calls (the female's opening notes command his silence during her aria), or are broadcast from his sleeping tree during a predawn chorus (*3*). The male begins this chorus as a simple phrase after which he is silent for a quarter-minute while listening to his neighbors reply in kind. During the next 45 minutes or so until dawn, the male gradually adds to and embellishes the phrase to make it an elaborate, varying, brief song. The female gibbon can utter the short calls of the male; the male, however, never sings the great call. Subtle differences characterize individuals (*3*), and often the subadult joins the bout of great calls (Fig. 1, line 6). Thus, territorial singing of the family broadcasts precise information on the species and sex of particular individuals, the area occupied by the parents, and the presence of a junior ready to form a new pair.

The siamang's great call (Fig. 1, top) is of barks alternating with booms resonated in a vocal pouch which the animal blows up like a balloon. Despite the bark's prominent harmonic, its pitch apparent to the human ear is that of the lower of the two parallel tones, lower also than the male's scream which is uttered at each of the two accelerations by the female. The song ends in a polyphonic tour de force marked by a rise in pitch of the female's bass line to harmonize with the thunderous pouch booms of the male.

The concolor gibbon's dialogue, at least in the zoo pair whose recordings are shown in Fig. 1, commences with a series of short phrases by the male to be interrupted by the great call, which reaches a climax at the highest pitch uttered by any gibbon (not markedly high in this particular, lethargic female), then subsides in a birdlike twitter. The male responds with a much longer, extemporized phrase than before.

Most of the morning singing of the Javan gibbon, *Hylobates moloch*, is a fe-

Fig. 1. Audiospectrograms of gibbon territorial songs.

male solo of great calls with subdued climax, rallentando. We have heard the male's hoots between great calls early in the bout.

The hoolock's territorial song includes an accelerated passage of alternating high and low notes reminiscent of the siamang, except that the bass line gradually ascends. It is an elaborate duet (*4*), yet we heard a single female at the Calcutta zoo render the entire score as a solo. Tilson, observing in Assam, found that the preliminary high note is the male's signal which precipitates a rendition of the great call by his mate.

The Kloss gibbon's great call is probably the finest music uttered by a wild land mammal. Following the magnificent central trill is a slow, stepwise descent in a low register. (The soft first and last low-pitched notes are barely visible on the sonogram.) The fully elaborated predawn phrase of the male includes a trill (*3*), not shown; we heard these lovely sounds at 4 a.m. on a moonlit night from Tenaza's camp on South Pagai.

The pileated gibbon's territorial song is a duet of the pair plus a male coda, whereas that of Mueller's gibbon is separated into male predawn and female morning solos. The great call, practically identical in these two taxa, illustrates "the peculiar bubbling noise they make" (*5*).

Individual variation and to some extent population dialects are responsible for the differences in length and number of climactic notes of the otherwise identical great calls of agile and lar gibbons (Fig. 1, lower six songs). The males indulge in predawn choruses, which they can also elaborate at other times of the day. They provide mandatory fillers between great calls, plus a distinctive coda thereto: "who-hah" in the agile gibbon, hoots and lugubrious quavering notes in the lar.

Gibbon vocalizations, well correlated with coloration (*6*), point toward the existence of nine species of *Hylobates*, provided that no substantial breakdown of reproductive isolation will be found at the contacts of *H. agilis* with *H. lar* in the vicinity of Lake Toba, Sumatra, and at the Thai-Malaysia frontier and between *H. agilis* and *H. muelleri* on Borneo. Finding this proof is complicated by deforestation at Lake Toba, terrorism and banditry at the Thai-Malaysia border, and the fact that on Borneo the two taxa of gibbons appear to have identical coloration.

In conclusion, the faithfulness of each species to its prescribed musical score, together with pronounced sexual divocalism, make the voices of gibbons seem a powerful guide to the isolation of species by appropriate pairing and restriction to territories. That the selective forces put a higher reward upon differentiation of the male's voice than of the female's is evident from those taxa distinguished vocally by only the male's part of the territorial song.

JOE T. MARSHALL, JR.
ELSIE R. MARSHALL
36 Soi Chaiyos 11, Sukhumvit, Bangkok, Thailand

References and Notes

1. Successfully used for *Cercopithecus* by T. Struhsaker, in *Old World Monkeys*, J. Napier and P. Napier, Eds. (Academic Press, New York, 1970), pp. 365–444.
2. J. Marshall, B. Ross, S. Chantarojvong, *J. Mammal.* **53**, 479 (1972).
3. R. Tenaza, *Z. Tierpsychol.*, in press.
4. Tenaza informs us that this observation is included in his detailed analysis of all gibbon vocalizations together with their social and evolutionary significance, which will appear as P. Marler and R. Tenaza, in *How Animals Communicate*, T. A. Seboek, Ed. (Indiana Univ. Press, Bloomington, in press).
5. C. Hose, *Mammals of Borneo* (Abbott, London, 1893), p. 60.
6. J. Marshall, Jr., and E. Marshall, *Mammal. Chromosomes Newsl.* **16**, 30 (1975).
7. We thank B. Galdikas-Brindamour, D. Holmes, P. Napier, B. Ross, K. Scriven, and R. Tilson for tape recordings which include songs used as audiospectrograms; D. Chivers, Greysolynne Fox, J. Romer, C. Wilson, and W. Wilson for additional tape recordings; Mr. Vandee Nongngork for assistance in the field; P. Winter, W. Brockelman, B. Chiarelli, D. Chivers, J. Delacour, A. Eudey, J. Fooden, P. Gittins, C. Groves, E. Mayr, J. McNeely, Lord Medway, P. Rand, R. Ronkin, B. Ross, R. Tenaza, R. Tilson, C. Wilson, and W. Wilson for information and comments on this report. We thank the authorities in charge and our colleagues for hospitality at the forest areas visited: Royal Thai Forest, Irrigation, Power, and Public Welfare Departments; Maxwell's Hill Station, Taiping; Office of the Chief Game Warden, Sandakan; Forest Department, North Sumatra and West Java; Museum Zoologicum Bogoriense and Herbarium Bogoriense; Messrs. Boeadi and G. Hambali (Java), R. Brindamour (Pangkalanbun), B. Smith (Sandakan), and R. Tenaza (Pagai). J.T.M. thanks SEATO Medical Research Laboratory, Bangkok, for travel within Thailand and photography.

7 May 1975; revised 22 September 1975

Fever: Effect of Drug-Induced Antipyresis on Survival

Abstract. *To determine whether the prevention of fever affects the survival of an animal infected with pathogenic bacteria, lizards (*Dipsosaurus dorsalis*) were infected with live* Aeromonas hydrophila *and received varying doses of sodium salicylate, an antipyretic drug. Twelve lizards received identical injections of bacteria along with a nontoxic dose of sodium salicylate; five animals increased their mean body temperature at least 0.6°C and survived the week, whereas seven did not develop a fever and died within 3 days. These data indicate that in these lizards the prevention of fever by use of an antipyretic drug such as sodium salicylate increases the mortality rate from bacterial infection.*

The desert iguana (*Dipsosaurus dorsalis*) develops a fever in response to infection with *Aeromonas hydrophila* (*1*), a gram-negative bacterium pathogenic to reptiles and amphibians. This fever results from the lizard's selection of a warmer microenvironment. Because the febrile response is similar in reptiles, birds, and mammals, and because the body temperature of an ectotherm, or behavioral thermoregulator, such as the desert iguana can be easily controlled at either the normothermic or febrile level by simply adjusting ambient temperature, *D. dorsalis* was proposed as a suitable animal model for study of the role of fever in disease (*2*). Lizards were infected with *A. hydrophila* and then placed in constant temperature chambers adjusted to between 34° and 42°C. At temperatures of 40° and 42°C (corresponding to low and high fever, respectively), the mortality of lizards attributable to infection with *A. hydrophila* was 33 and 0 percent, respectively. The mortality at 38°C (the normal body temperature of afebrile or uninfected lizards) was 75 percent. These data indicated that an elevation in body temperature led to a significant reduction in host mortality (*2*).

In mammals, fever is often reduced by administering an antipyretic drug such as sodium salicylate (*3*). This drug produces effective antipyresis in reptiles and birds inoculated with dead bacteria (*4, 5*). However, the effects of drug-induced antipyresis on the survival of mammals, birds, or reptiles infected with pathogenic bacteria have not been determined. Because of the results described above (*2*), we suspected that the administration of a dose of sodium salicylate sufficient to produce an attenuation of fever in *D. dorsalis* would lead to a significant increase in host mortality. We report here that whereas the development of fever in *D. dorsalis* results in low mortality (less than 10 percent), suppression of fever by an injection of a nontoxic dose of sodium salicylate results in substantial mortality (100 percent in these studies).

Lizards (*D. dorsalis*) weighing 25 to 45 g (Hermosa Reptile Farm, Hermosa, California) were housed at an ambient temperature of 22° to 24°C in circular cages and had free access to mealworms, lettuce, and water. The cages were kept on a photoperiod of 12 hours light and 12