peatedly cut down to the levels of the glacially lowered Pleistocene sea (*6*).

From the foregoing, it seems that living oceanic reefs, as well as reefs of continental margins, may be only thin veneers over older foundations (*8*). Fossil reefs well above present sea level, situated in many cases near shelf margins, may represent exposed parts of the Pleistocene foundation. Widely distributed, elevated marine terraces and reefs of the western Atlantic antedate the last time of widespread dune formation, which apparently occurred during the last interglacial stage. Elevated terraces of Pacific islands, frequently cited (with insufficient evidence) as effects of recent high sea level, should be critically re-examined. It seems likely that they also are of Pleistocene age.

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References and Notes

1. N. D. Newell and J. K. Rigby, *Soc. Econ. Paleontologists Mineralogists, Spec. Paper No. 5* (1957), p. 68.
2. C. A. Kaye, *U.S. Geol. Survey Profess. Paper No. 317-B* (1959), p. 128.
3. Wallace Broecker, personal communication.
4. M. Tatsumoto and E. D. Goldberg, *Geochim. et Cosmochim. Acta* **17**, 205 (1959).
5. H. Lowenstam, personal communication.
6. P. H. Kuenen, *Marine Geology* (Wiley, New York, 1950).
7. F. S. MacNeil, *Bull. Geol. Soc. Am.* **61**, 1307 (1950); R. W. Fairbridge, *Proc. Pacific Sci. Congr. Pacific Sci. Assoc., 7th Congr.* (1952), vol. 3, p. 1; P. E. Cloud, Jr., *Sci. Monthly* **79**, 195 (1954).
8. N. D. Newell, *Nat. History* **68**, 128 (1959).

23 March 1960

Y-Chromosome Inheritance of Hairy Ears

Abstract. A pedigree of hairy ear rims published in Italy in 1907 indicated holandric inheritance. The recent collection of over 20 pedigrees in India appears to show conclusively that the gene for hairy ear rims is in the Y chromosome. This is further evidence of relationship between the Mediterranean race in Europe and the population of India.

When I wrote *Human Genetics* (*1*), an Italian pedigree of hairy ear rims was regarded as a prima facie case of inheritance through a gene in the Y chromosome. But, since the pedigree was published very early (1907) and not in pedigree form, it obviously needed confirmation. While traveling in Africa in 1955, I accidentally observed three cases of hairy ears (*2*) in East Indians, two of whom were from Goa. Their pedigrees, so far as they could be obtained, were consonant with holandric inheritance, but did not furnish final proof.

In a detailed examination of all possible cases of Y chromosome inheritance in the literature, Stern (*3*) rightly suspends judgment about hairy ears, suggesting that unaffected women might transmit the trait, in which case it might be an autosomal character under sex control. Transmission from a father to all his sons, which is the pattern found, shows that the gene cannot normally be in the X chromosome, because a father always transmits his X chromosome to all his daughters and his Y to all his sons.

While studying jungle tribes in India in 1959, I collected over 20 pedigrees of hairy ear rims, generally in three generations, from the ordinary Indian population. The condition proved to be relatively frequent, especially in southern India. Two cases in native tribes, one in the Kotas and one in the Adiyar, were probably the results of miscegenation with ordinary Indian men.

The pedigrees as a whole show beyond any doubt that hairy ear rims are holandric. The inheritance is always from a father to all his sons, except in rare cases of lack of penetrance. Such exceptions are not surprising, for the amount of hair in the groove of the ear rim varies widely, even in the same family.

That the daughters of affected men do not transmit the condition is shown by three sibships in one pedigree, in which a total of ten sons (ages 33 to 54) are unaffected. In two cases there is the possibility of crossover from Y to X, but other explanations are equally likely. The condition generally develops at ages 20 to 25, and it appears to be quite independent of a hairy external auditory meatus, which is frequently found in older men of European descent. The inheritance of the latter condition has apparently never been investigated.

It appears to be significant that hairy ear rims are found in Italians (of Mediterranean race) and in the Dravidian, Indide, or Brown race in India—which is generally regarded as an Eastern extension of the Mediterranean race.

It may also be worth mentioning that in a single Australian aboriginal of the Pintubi tribe, a fringe of hairs, little more than fuzz, was observed in the ear rims (*4*). That this fringe of hairs in the ears may have wider parallelisms is shown by its occurrence in certain species of marmosets and South American monkeys, but not in other species (*5*).

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References

1. R. R. Gates, *Human Genetics*, 2 vols. (Macmillan, New York, 1946).
2. ———, *Acta Genet. Med. et Gemellol.* **6**, 103 (1957).
3. C. Stern, *Am. J. Human Genet.* **9**, 147 (1957).
4. R. R. Gates, *Acta Genet. Med. et Gemellol.* **9**, 10 (1960).
5. W. C. O. Hill, *Primates*, vol. 3 (Interscience, New York, 1957).

2 May 1960

Locomotor Activity of Land Crabs during the Premolt Period

Abstract. When maintained in darkness, premolt specimens of *Gecarcinus lateralis*, with or without eyestalks, show variations in level of activity according to six distinct stages. Furthermore, in darkness the rhythmic pattern of premolt crabs with eyestalks resembles that of eyestalkless premolt crabs, the intervals between principal bursts of activity being generally shorter than in nonpremolt crabs.

The spontaneous locomotor activity of land crabs, *Gecarcinus lateralis* (Fréminville), has been investigated in terms of two important characteristics, namely, (i) magnitude or level, and (ii) rhythmicity. It has already been reported that the magnitude or level of activity shown by eyestalkless individuals during the period elapsing between eyestalk removal and molt fluctuates according to six distinct stages, with the level variable during stage I, relatively high in stages III and V, and relatively low or even nonexistent in stages II,

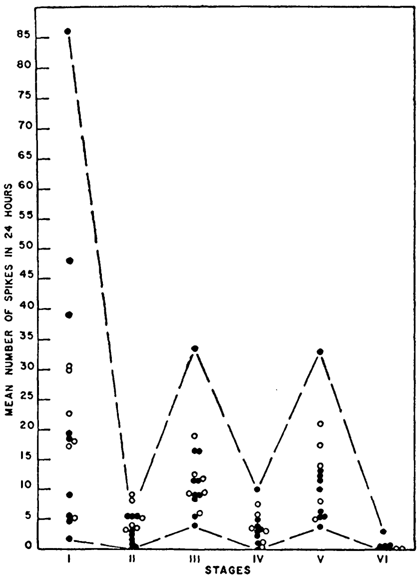

Fig. 1. Variations in level of activity recorded in darkness at 27°C from six specimens with eyestalks (open circles) and ten eyestalkless specimens (closed circles) of *Gecarcinus lateralis* during the period just prior to molt. For explanation of stages, see text.

IV, and VI (*1*). It can now be reported here that in darkness, specimens of *G. lateralis* still in possession of their eyestalks show a comparable pattern of variability in level of activity during the period just prior to molt.

These new findings are based on information derived from extended recordings in darkness at 27°C on six crabs possessing eyestalks. For some weeks these crabs had been exposed to 12 hours of continuous artificial light and 12 hours of continuous darkness every 24 hours before being placed in the activity chambers. Three crabs molted on the 21st, 22nd, and 40th day, respectively, after first exposure to darkness. The remaining three crabs did not molt until the 72nd, 78th, and 180th day, respectively, after first exposure. Despite wide variation in length of time elapsing before molt, each crab, just prior to molt (*2*), showed fluctuations in level of activity comparable to those reported earlier for 10 eyestalkless crabs. Figure 1 gives these variations in level for both eyestalkless crabs and crabs retaining their eyestalks. No attempt has been made in Fig. 1 to indicate the duration of each stage of activity. Duration depends upon several different factors, including season of the year and size of the crab.

Gecarcinus lateralis exhibits a diurnal (diel) rhythm of locomotor activity in the field, with the active period occurring at night (*3*). Likewise, in the laboratory, when it is exposed to natural daylight and night, this crab tends to be active at night and quiescent during the day. The overt diurnal rhythm of activity in the laboratory persists when a crab previously exposed to natural daylight and night is placed in constant darkness.

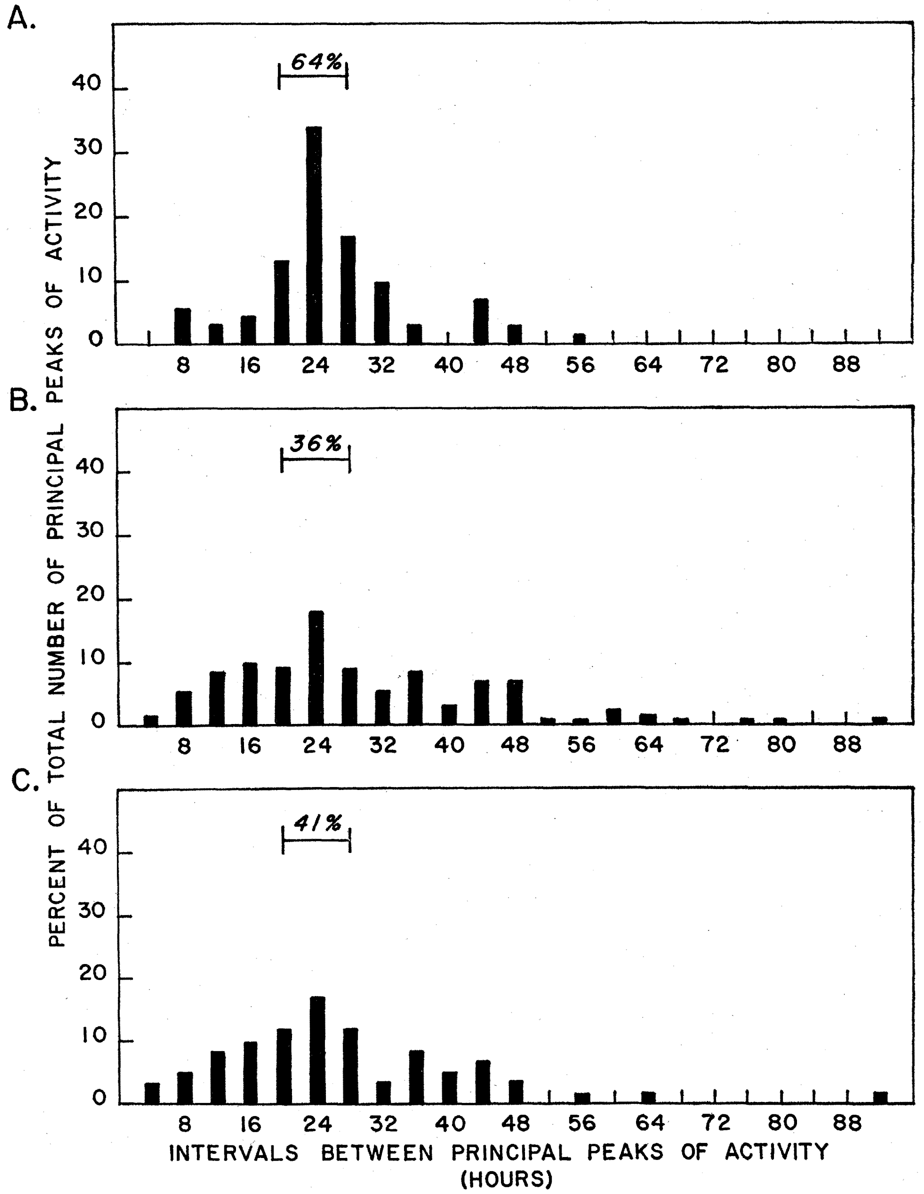

Fig. 2. Percentage distribution of the principal peaks of activity as recorded in darkness at 27°C from (*A*) three nonpremolt crabs (*Gecarcinus lateralis*) possessing eyestalks, (*B*) six crabs with eyestalks during the premolt period, and (*C*) four eyestalkless crabs during the premolt period. Counts were made at successive intervals of 4 hours.

Persistence of overt rhythmic activity in constant darkness at 27°C has now been demonstrated for six nonpremolt specimens of *G. lateralis* with eyestalks after prolonged exposure of these crabs to 12 hours of continuous artificial light and 12 hours of continuous darkness every 24 hours. Activity records made by these crabs show a period length somewhat different from 24 hours. For instance, in commencing its active period, one crab that had been in constant darkness for 101 days exhibited a more or less regular daily delay of approximately 1.4 hours, thus yielding a period length of 25 hours 25 minutes. Periods with a natural length somewhat greater or less than 24 hours have been reported for many plants and animals maintained under constant environmental conditions (*4*).

When, in darkness, a crab that retains its eyestalks approaches molt, its rhythm of locomotor activity becomes increasingly variable in phase and continues to vary in this way for at least 1 or 2 weeks following ecdysis, while hardening of the new exoskeleton is being completed. A comparable variability in phase occurs in this species of crab when premolt growth is induced by eyestalk removal (*3*).

During analysis of activity records, counts of activity spikes appearing on the recordings are made for successive intervals of 4 hours. Peaks of activity can be recognized within any given 24-hour period, the highest being designated the "principal peak of activity." In Fig. 2 there appears the percentage distribution of principal peaks of activity at various 4-hour intervals as recorded in darkness from eyestalkless crabs and from crabs retaining their eyestalks. In nonpremolt crabs with eyestalks (Fig. 2*A*), a 24-hour period intervened between principal peaks of activity during 34 percent of the time, while principal peaks separated by 20 to 28 hours occurred during 64 percent of the time. The pattern changed markedly when a crab possessing eyestalks approached molt (Fig. 2*B*). Now principal peaks of activity occurred at 24-hour intervals during only 18 percent of the time and separation of principal peaks by periods of 20 to 28 hours occurred during only 36 percent of the time. In eyestalkless premolt crabs (Fig. 2*C*), principal peaks of activity occurred at 24-hour intervals during 17 percent of the time and were separated by intervals of 20 to 28 hours during 41 percent of the time. Thus premolt crabs, whether with or without eyestalks, manifest a weakened diurnal rhythm. Their principal peaks of activity tend to be separated often by relatively short intervals, mainly those of 12 and 16 hours.

The results of this work indicate that in terms of locomotor activity a premolt crab that retains its eyestalks and one that is eyestalkless are not dissimilar. In level and in rhythmicity, locomotor activity after eyestalk removal appears to follow a pattern characteristic of any crab in darkness making preparations for molting, including one that retains its eyestalks. One may suggest that alterations in locomotor activity during the premolt period may be attributed in an eyestalkless crab to the loss of centers for the synthesis and release of molt-inhibiting hormone and, in a crab possessing its eyestalks, to the withholding of molt-inhibiting hormone from the hemolymph. There is a strong possibility that responsibility for the control of locomotor activity in *G. lateralis* may rest with that portion of the neuroendocrine system concerned with the regulation of molting. The changes noted in darkness concerning the intensity and rhythmicity of locomotor activity prior to molt may, like rapid limb regeneration and precocious uptake and retention of water (see *5*), be part of preparations for molting and therefore a sign that ecdysis is imminent.

In conclusion, it may be suggested that since eyestalk removal appears to weaken but not to destroy the 24-hour rhythm of locomotor activity, it would seem that in the land crab, *G. lateralis*, either the biological clock does not reside in the eyestalks or accessory clocks exist elsewhere (*6*).

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References and Notes

1. D. E. Bliss and P. C. Sprague, *Anat. Rec.* **132**, 417 (1958).
2. Proximity to molt is determined by use of a regenerating limb as an index. (For descriptions of this method, see *5*.)
3. D. E. Bliss and P. C. Sprague, *Anat. Rec.* **132**, 416 (1958).
4. E. Bünning, *Die Physiologische Uhr* (Springer-Verlag, Berlin, 1958), p. 10; J. E. Harker, *Biol. Rev. Cambridge Phil. Soc.* **33**, 23 (1958); K. S. Rawson, in *Photoperiodism and Related Phenomena in Plants and Animals*, R. B. Withrow, Ed. (American Association for the Advancement of Science, Washington, D.C., 1959), p. 796; V. G. Bruce and C. S. Pittendrigh, *Am. Naturalist* **91**, 190 (1957); C. S. Pittendrigh and V. G. Bruce, in *Rhythmic and Synthetic Processes in Growth*, D. Rudnick, Ed. (Princeton Univ. Press, Princeton, N.J., 1957), p. 90.
5. D. E. Bliss, in *Bertil Hanström. Zoological Papers in Honour of his 65th Birthday*, K. G. Wingstrand, Ed. (Zoological Institute, Lund, Sweden, 1956), p. 56; D. E. Bliss, in *Physiology of Crustacea*, T. H. Waterman, Ed. (Academic Press, New York, 1960), vol. 1, p. 561.
6. This work was supported by research grant G-4006 from the National Science Foundation. A detailed account of these studies is in preparation.

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Late Tertiary Microflora from the Basin and Range Province, Arizona

Abstract. Sediments of probable Clarendonian age from central Arizona have furnished the only late Tertiary pollen assemblage known from the Southwest. The associated trees, shrubs, and herbs resemble the chaparral and conifer-oak woodland communities of the semiarid foothills and mountains of central and southeastern Arizona, and suggest a late Tertiary landscape and climate for central Arizona similar to that of today.

A well-preserved microflora from central Arizona provides the first good record of the late Tertiary vegetation of an area remarkable for its scarcity of Tertiary plant mega- and microfossils (*1*). The recently discovered fossil site occurs near 5600 feet altitude in the mountains of the Basin and Range Province, about 4 miles northwest of Prescott and 30 to 40 miles southwest of the Colorado Plateau.

The polliniferous sediments are a rhyolitic tuff, at least in part water-laid, sandwiched between volcanic flows. The sequence is similar in lithology and probably more or less equivalent in age to the Hickey formation (*2*) described from the adjacent Jerome area to the east and tentatively assigned to the Pliocene (*3*). Recently, Lance (*2*) has discovered fragmentary camel bones in tuffs within a few feet below the pollen-yielding sediments; he thinks these remains are like some from the Walnut Grove fauna, found in similar lithologic sequence, about 20 miles south of Prescott. This fauna contains elements indicating a Clarendonian provincial age (*2*). Reference of the polliniferous sediments to the late Miocene or early Pliocene seems in line with the regional geology and paleontology.

Scattered thick deposits of gravel and interbedded volcanics, through much of central Arizona and along the southern margin of the Colorado Plateau, indicate widespread crustal disturbance, uplift, and volcanism in the area during the late Miocene or early Pliocene (*4*). Concurrent deformations in southern Arizona are considered to have been "of mountain-building proportions" (*5*) and there seems to be good evidence that a major disturbance also raised the central Arizona upland locally, as at Prescott, higher than the Plateau blocks (*4*), which were also uplifted about this time (*6*).

Direct geologic evidence for determining the exact Mio-Pliocene altitude of the Prescott area, and of central Arizona in general, is lacking, but the information available strongly suggests at least moderate elevation, and a landscape locally dotted with mountains and volcanic cones possibly of sufficient height to support a montane forest. The Prescott microflora approximates today's foothill and slope vegetation (4000 to 5500 feet) of central and southeastern Arizona, corroborating, in part, the landscape configuration surmised from geologic evidence.

Oak chaparral and ponderosa pine forest are now the main vegetation types near the fossil site; pinyon-juniper woodland and grama grassland are prominent nearby. The relative abundance of components in a pollen rain derived from this vegetation is indicated in Table 1. The sediment analyzed (one of a series studied for this area) is a lake mud from the same elevation as the fossil site. Table 1 also shows the relative abundance of plants identified to date from the fossil pollen assemblage (*7*).

Except for elm, the identified fossils

Table 1. Frequency of components in fossil (Prescott) and modern (Granite Basin Lake) sediments. Plus mark indicates pollen seen on scan. (Some of those listed for the lake sediments were found only at adjacent localities, at elevations, in feet, shown in parentheses.)

Genus or family	Prescott microflora N = 499 (%)	Granite Basin Lake (5600 feet) N = 631 (%)
	Arborescent pollen	
Quercus	23.8	33.1
Pinus	16.4	33.6
Juniperus-Cupressus	15.8	4.0
Juglans	0.6	2.5
Fraxinus	.4	+
Celtis	.2	+ (5400)
Alnus	+	+ (5500)
Betula	+	+
Ceanothus (*Rhamnus?*)	+	0.3
Ephedra	+	+ (5100)
Ulmus	+	+ (5400)
Agave		0.2
cf. *Garrya*		0.2
Opuntia		0.2
Vitis		0.2
	Nonarborescent pollen	
Gramineae	10.8	2.5
Compositae	8.0	5.8
Artemisia (shrub?)	0.8	0.3
Chenopodiaceae-*Amaranthus*	5.2	1.3
Cyperaceae	1.0	2.5
Eriogonum (shrub?)	0.2	0.2
Malvaceae cf. *Sphaeralcea*	+	+
Polypodiaceae? (trilete spore)	+	+ (5100)
Typha	+	4.6
Plantago		1.7
Polygonum		0.6
Geranium (*Erodium?*)		0.2
Papilionoideae (shrub?)		0.2
	Unknowns	
Tricolporites a	4.6	
Tricolpites a	2.4	
Other	10.4	6.1