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QUATERNARY INSECTS OF THE CALIFORNIA ASPHALT DEPOSITS

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ABSTRACT--Asphalt impregnated sediments at Rancho La Brea (Los Angeles Co.), McKittrick (Kern Co.), and Carpinteria (Santa Barbara Co.) in California provide a rich Quaternary insect record. Ages range from over 50,000 radiocarbon years to modern. The major paleoecological groupings are: (1) ground dwellers, (2) aquatics, (3) scavengers, and (4) miscellaneous. Contrary to conclusions of earlier authors, most specimens represent modern species. Only two documented terminal Pleistocene extinctions are known, both dung beetles (Scarabaeidae).

Late Quaternary insect-bearing asphalt deposits which are similar in many respects (Akersten 1980), occur near Talara, Peru (Churcher 1966), Fyzabad, Trinidad (Blair 1927), Binagady, Caucasus region of U.S.S.R. (Bogachev 1948), and California. The California asphalt deposits (especially Rancho La Brea) are well known for their Late Pleistocene vertebrates, but the abundant invertebrate and plant fossils have been little studied. A few entomologists have published on the insects of these deposits, but most early papers contain significant errors in identifications and interpretations. This paper summarizes the paleoecological data from a series of papers (Doyen and Miller 1980, Gagne and Miller 1982, Miller 1978, Miller *et al.* 1981, Miller and Peck 1979, Moore and Miller 1978, and Nagano and Miller ms) on the insects of Rancho La Brea, McKittrick, and Carpinteria asphalt deposits.

W.D. Pierce authored most of the publications on Rancho La Brea and McKittrick insects. Although he was among the first workers in North America to appreciate the significance of Quaternary insects and their potential as paleoecological indicators (Pierce 1961, Ashworth 1979), Pierce's papers and taxonomic procedures were replete with errors. Serious problems result from his erection of taxa based on fragmentary specimens; Pierce felt that fragments he could not associate with known species should be described as new taxa so that they could be considered "identified." His taxonomic procedures and lack of modern ecological data also led him to radical paleoecological conclusions (*e.g.* Miller and Peck 1979:99).

RANCHO LA BREA

The Rancho La Brea asphalt deposits are located in Hancock Park, Los Angeles, Los Angeles County, California. Before the reopening of Pit 91 in 1969, emphasis was placed on large vertebrates; Pierce's material was largely salvaged from the miscellaneous material associated with the vertebrate collections at the Natural History Museum of Los Angeles County (LACM). Future studies should be directed toward insects taken by the Rancho La Brea Project from the reexcavation of Pit 91; the earlier collections, which are almost entirely lacking in detailed stratigraphic data, are best used only as a supplement to the more significant Pit 91 material. For additional background see Kurten and Anderson (1980), Miller and Peck (1979), Stock(1956),and Woodard and Marcus(1973).

The popular generalization of accumulation of fossils at Rancho La Brea presents a picture of great pools of continuously active liquid asphalt ("tar pits") which trapped unwary animals; these in turn attracted scavengers which also became trapped. However, recent studies indicate that such "death traps" had only a minor role in the accumulation of fossils. Reinterpretation of stratigraphy, and radiocarbon dating indicate that the fossil deposits were formed at the sites of discontinuously active asphaltic seeps during the accumulation of alluvium from Late Pleistocene to present. Most deposits are stratified and can be correlated with facies of surrounding sediments which are not oil impregnated. The "pits" at Rancho La Brea were artifacts of excavation, and did not represent naturally occurring deep pools of liquid asphalt. While the larger and more continuous fossil accumulations probably represent areas where animals were mired in flows or small pools of asphalt, many of the smaller accumulations probably represent localized fluvitile concentrations of bones in stream channels or ponds. Once buried, the fossils were impregnated by asphalt premeating upwards and laterally.

McKITTRICK

The classic vertebrate fossil localities (*e.g.* Schultz 1938) are about 0.8 km south of McKittrick, Kern County, in the southern San Joaquin Valley of California. This biota is considered Late Pleistocene although there is some "admixture of a later (Recent, but not present-day) assemblage" (DeMay 1941). Plant material from a University of California excavation (lacking further data) yielded a radiocarbon date of 38,000 $\pm$ 2500 years before present (UCLA-728 in Berger and Libby 1966). Schultz (1938), Sternburg (1932), and Blum (undated field notes at LACM) all mention the occurrence of younger layers of better stratified asphaltic matrix containing insects and only small vertebrates, above the Pleistocene vertebrate bearing layers of these original localities. An additional deposit similar to McKittrick is located near Maricopa (also in Kern County), but its insect fauna has not been studied.

Pierce's sites 3 and 4 (LACM Invert. Paleo. Loc. 260) were southeast of the original localities, east of the present State Highway 33 about 1.2 km south of McKittrick (Pierce 1947, Miller and Peck 1979). Stratigraphic and age relationships of Pierce's localities to the classic localities have not been

determined , but Pierce's localities appear to be much younger (radiocarbon dates pending). Specimens reported by Essig (1931) from an unstated locality(s) probably came from surface layers similar in age to Pierce's sites 3 and 4.

Schultz (1938) summarized McKittrick taphonomy: "...oil reached the surface from numerous small discontinuously active petroleum seeps and spread out in sheets a fraction of an inch or so in thickness [and] it became intercalated with clay, sand, gravel, and windblown material. The resulting product is a rudely stratified material consisting of fine and coarse sediments more or less uniformly saturated with petroleum. The upper layers which contain a Recent vertebrate fauna seem to be somewhat better stratified than the lower levels which contain the Pleistocene vertebrates. ...during the summer months ... oil became fluid enough to spread over large areas; while the winter rains carried in most of the clastic material."

CARPINTERIA

The Carpinteria asphalt deposit is located about 1.5 km southeast of Carpinteria, Santa Barbara County, California. Fossils were excavated from the asphalt mine there starting in 1927. The mine was later abandoned and the site used as a refuse dump beginning in the 1940s. Limited insect material is available from the early excavations (Doyen and Miller 1980, Lance 1946, Miller 1978, Miller and Peck 1979, Moore and Miller 1978), and the fossil deposits are now inaccessible. Radiocarbon dating indicates an age of greater than 50,000 years (Miller and Peck 1979).

PALEOECOLOGY

Interpretation of accumulation and preservation in asphaltic matrix is difficult, but two distinct processes appear to be involved: direct preservation (*i.e.* entrapment in viscous asphalt) and indirect preservation (*i.e.* impregnation with asphalt subsequent to death and burial). Accumulation of asphalt deposits occurs in two major ways (*e.g.* Campbell 1979): the horizontal flow (forming thin, radiating layers) and the filling of natural depressions (forming lense-like deposits). The former accumulation is more common at McKittrick, the later more common at Rancho La Brea, but both seem to occur at each locality.

Entrapment of insects occurs in four ways: (1) attraction to carrion or other material already in contact with asphalt, to be expected among the scavenging insects; (2) attraction, especially of aquatic species to pools of oil and water which appear as water (*e.g.* Pierce 1949: fig. 6); (3) attraction to asphalt itself; some insects are attracted to fresh tar coating roads (Saylor 1933, Borell 1936, Hubbs and Walker 1947), and some to burning oil (Van Dyke 1926, Linsley 1933). This attraction may be due however, to the warmth of the roads and fires. Deposits of apparently burned asphalt at Rancho La Brea and McKittrick indicate natural asphalt fires have occurred there (W.A. Akersten, pers. comm.); (4) accidental trapping without attraction when insects crawl or fall into asphalt and are not able to free themselves. In practice, taphonomy is a product of all these processes, each of which has occurred at modern asphalt seeps, but the relative importance of each process is not known. The physical characteristics of the asphalt seep and the circumjacent microhabitat(s) are also important; some species may have been more attracted than others to the particular microhabitat(s) present.

Brea insect fossils may be placed in the following crude paleoecological classification: (1) *aquatic* and semi-aquatic species which lived in water overlying the tar or were attracted to tar appearing as water; (2) *scavenging* species which lived on or were attracted to carrion or dung; (3) *ground-dwelling* beetles and other terrestrial crawling species; (4) *miscellaneous* stray individuals of herbivorous and other species which are not preserved in significant numbers; (5) fragments of insects from feces and gut contents of vertebrates. It is presently not possible to distinguish members of the minor last category from the others, but careful studies of vertebrate feeding habits (*e.g.* Mayhew 1977) may eventually allow differentiation.

Although the paleoecological conclusions that can be drawn from California brea entomofaunas are limited at present, further study of the modern and fossil faunas promises to allow significant contributions to paleoecology (such as those possible in Europe, where the modern fauna is well known). The Brea insects offer data not only on Quaternary climatic changes, but also on changes in community composition. This will allow evaluation of postulated terminal Pleistocene changes in community ecology.

EXTINCTION

Widespread extinction among large vertebrates at the end of the Pleistocene was probably due largely to climatic and resultant ecological changes, with perhaps some influence from human hunting (*e.g.* Johnson 1977, Martin and Wright 1968). Axelrod (1967) and Martin and Neuner (1978) have suggested that low seasonality of Pleistocene environments permitted the establishment of very complex communities that lack modern analogues, and that the inception of Holocene seasonal environments was a major cause of terminal Pleistocene extinctions. Many extinct birds and mammals are known from the California asphalt deposits. Invertebrates other than insects have not been adequately studied, but none have been recognized as extinct. No extinct plants are known from any of the California asphalt deposits (Miller 1979).

Studies elsewhere in North America (Ashworth 1979, Matthews 1977) and in Europe (Coope 1978) indicate that almost no extinction of insects took place at the end of the Pleistocene. At Rancho La Brea and McKittrick, the extinction picture has been clouded by Pierce's many supposedly extinct taxa. Most of these have now been placed in synonymy of extant taxa, others have been recognized as extinct, and others are impossible to identify because of the nature of the types and the taxonomic condition of the groups concerned. For example, it is presently impossible to properly identify *Serica kanakoffi* Pierce 1946, but there is no good reason to assume it is not conspecific with an extant (but unidentified) species. *Serica* is a large, poorly understood genus of plant feeding beetles; it is best to assume this species to be extant until contrary evidence is found. The specific identity of the scarab *Phaneaus labreae* (Pierce 1946) also cannot be determined due to the broken and distorted condition of the holotype. The millipede *"Spirobolus" australis* Grinnell 1908 is another unidentifiable taxon, known only from the fragmentary types, which lack diagnostic characters necessary for identification. *Coniontis remnans* Pierce 1954 is not conspecific with any described species (Doyen and

Miller 1980), but this does not mean it is extinct. *Coniontis* is a genus of numerous poorly understood species, probably including at least several undescribed species. *C. remnans* probably still lives in southern California, but has not yet been recognized (most *Coniontis* in museum collections are unidentified or misidentified).

The scarab beetles *Copris pristinus* Pierce 1946 and *Onthophagus everestae* Pierce 1946 appear to be extinct. The most closely related species occur today in Mexico (and into Texas for *Copris*) and are associated with mammal dung. It is probable that the reduction of dung availability due to terminal Pleistocene mammal extinctions, as well as direct effects of the changing climate caused the demise of these scarabs. However, even if the large mammal fauna had survived into the Holocene, the scarabaeine fauna of California might not have survived the present seasonal dry periods, since their successful reproduction requires adequate moisture (Miller *et al.* 1981). It is, of course, possible that one or both of these species still lives in inadequately collected regions of Mexico and remains to be rediscovered.

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REFERENCES

Akersten, W. A. 1980. Fossils in asphalt. Science 208: 552.

Ashworth, A. C. 1979. Quaternary Coleoptera studies in North America: past and present. pp. 395-406 in Erwin, T. L., G. E. Ball, and D. R. Whitehead (eds) Carabid beetles: Their evolution, natural history, and classification. Dr. W. Junk B.V., The Hague.

Axelrod, D. I. 1967. Quaternary extinctions of large mammals. Univ. Calif. Publ. Geol. Sci. 74: 1-42.

Berger, R. and W. F. Libby. 1966. UCLA radiocarbon dates V. Radiocarbon 8:467-497.

Blair, K. G. 1927. Insect remains from oil sand in Trinidad. Trans. Ent. Soc. Lond. 75: 137-141.

Bogachev, A. 1948. Fauna of the Binagady asphalt deposits: Coleoptera. Trudy Eestesvenno-Istorich-eskii Muzei, Baku 1-2: 137-160. (in Russian)

Borrell, A. E. 1936. A modern La Brea tar pit. Auk 53: 298-300.

Campbell, K. E., Jr. 1979. The non-passerine Pleistocene avifauna of the Talara tar seeps, Northwestern Peru. Roy. Ont. Mus., Life Sci. Cont. 118: 1-203.

Churcher, C. S. 1966. The insect fauna from the Talara tar-seeps, Peru. Can. J. Zool. 44: 985-993.

Coope, G. R. 1978. Constancy of insect species versus inconstancy of Quaternary environments. Symp. Roy. Ent. Soc. Lond. 9: 176-187.

DeMay, I. S. 1941. Quaternary bird life of the McKittrick asphalt, California. Carnegie Inst. Wash. Publ. 530: 35-60.

Doyen, J. T. and S. E. Miller. 1980. Review of Pleistocene darkling ground beetles of the California asphalt deposits (Coleoptera: Tenebrionidae, Zopheridae). Pan-Pac. Ent. 56: 1-10.

Essig, E. O. 1931. A history of entomology. MacMillan, New York. 1029 pp.

Gagne, R. J. and S. E. Miller. 1982. *Protochrysomyia howardae* from Rancho La Brea, California, Pleistocene, new junior synonym of *Cochliomyia macellaria* (Diptera: Calliphoridae). Bull. So. Calif. Acad. Sci. 80: in press.

Grinnell, F. 1908. Quaternary myriapods and insects of California. Univ. Calif. Publ. Geol. 5: 207-215.

Hubbs, C. L. and B. W. Walker. 1947. Abundance of desert animals indicated by capture in fresh road tar. Ecology 28: 464-466.

Johnson, D. L. 1977. The California ice-age refugium and the Rancholabrean extinction problem. Quat. Res. 8: 149-153.

Kurten, B. and E. Anderson. 1980. Pleistocene mammals of North America. Columbia Univ. Press, New York. 443 pp.

Lance, J. F. 1946. Fossil arthropods of California. 9. Evidence of termites in the Pleistocene asphalt of Carpinteria, California. Bull. So. Calif. Acad. Sci. 45: 21-27.

Linsley, E. G. 1933. Some observations on the swarming of *Melanophila*. Pan-Pac. Ent. 9: 138.

Martin, L. D. and A. M. Neuner. 1978. The end of the Pleistocene in North America. Trans. Nebr. Acad. Sci. 6: 117-126.

Martin, P. S. and H. E. Wright, Jr. (eds). 1967. Pleistocene extinctions: The search for a cause. Yale Univ. Press, New Haven. 453 pp.

Matthews, J. V., Jr. 1977. Tertiary Coleoptera fossils from the North American arctic. Coleop. Bull. 31: 297-308.

Mayhew, D. F. 1977. Avian predators as accumulators of fossil mammal material material. Boreas 6: 25-31.

Miller, S. E. 1978. A fossil of *Scaphinotus interruptus* from the Pleistocene Carpinteria asphalt deposit, Santa Barbara County, California (Coleoptera, Carabidae). Pan-Pac. Ent. 54: 74-75.

Miller, S. E. 1979. Reevaluation of *Pyrus hoffmannii* (Rosaceae) from the Pleistocene Carpinteria asphalt deposit, California. Madrono 26: 190-191.

Miller, S. E., R. D. Gordon, and H. F. Howden. 1981. Reevaluation of Pleistocene scarab beetles from Rancho La Brea, California (Coleoptera:Scarabaeidae). Proc. Ent. Soc. Wash. 83: 625-630.

Miller, S. E. and S. B. Peck. 1979. Fossil carrion beetles of Pleistocene California asphalt deposits, with a synopsis of Holocene California Silphidae (Insecta: Coleoptera: Silphidae). Trans. San Diego Soc. Nat. Hist. 19: 85-106.

Moore, I. and S. E. Miller. 1978. Fossil rove beetles from Pleistocene California asphalt deposits (Coleoptera: Staphylinidae). Coleop. Bull. 32:37-39.

Pierce, W. D. 1946. Fossil arthropods of California. 11. Descriptions of the dung beetles (Scarabaeidae) of the tar pits. Bull. So. Calif. Acad. Sci. 45: 119-131.

Pierce, W. D. 1946. Fossil arthropods of California. 12. Description of a sericine beetle from the tar pits. Bull. So. Calif. Acad. Sci. 45: 131-132.

Pierce, W. D. 1947. Fossil arthropods of California. 14. A progress report on the McKittrick asphalt field. Bull. So. Calif. Acad. Sci. 46: 138-143.

Pierce, W. D. 1949. A modern asphalt seep tells a story. Los Angeles Co. Mus. Quarterly 7(3): 12-17.

Pierce, W. D. 1954. Fossil arthropods of California. No. 20. The Tenebrionidae-Coniontinae of the asphalt deposits. Bull. So. Calif. Acad. Sci. 53: 142-156.
Pierce, W. D. 1961. The growing importance of paleo-entomology. Proc. Ent. Soc. Wash. 63: 211-217.
Saylor, L. W. 1933. Attraction of beetles to tar. Pan-Pac. Ent. 9: 182.
Schultz, J. R. 1938. A Late Quaternary mammal fauna from the tar seeps of McKittrick, California. Carnegie Inst. Wash. Publ. 487: 111-215.
Sternberg, C. H. 1932. Hunting dinosaurs on Red Deer River, Alberta, Canada. Publ. by author, San Diego. 261 pp.
Stock, C. 1956. Rancho La Brea: a record of Pleistocene life in California. Los Angeles Co. Mus. Nat. Hist. Sci. Ser. 20: 1-81.
Van Dyke, E. C. 1926. Buprestid swarming. Pan-Pac. Ent. 3: 41.
Woodard, G. D. and L. F. Marcus. 1973. Rancho La Brea fossil deposits: a re-evaluation from stratigraphic and geological evidence. J. Paleo. 47: 54-69.