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ON THE IDENTIFICATION OF *SCHIZOPYGA*
CALIFORNIANA CONRAD, A CALIFORNIA
PLIOCENE GASTROPOD¹

By

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ABSTRACT

Widely differing identifications of the Pliocene gastropod originally described as *Schizopyga californiana* Conrad (1856), but now placed in the genus *Nassarius*, have resulted from a vague original description, poor figure, and missing type specimen. Isolated exposures of marine upper Pliocene strata in northwestern Santa Clara County, California, considered to be laterally equivalent to the generalized type locality of this species, contain two species of *Nassarius*. One, a rather small slender species particularly characteristic of these strata, closely resembles the type figure and is believed to be Conrad's species. Several other late Cenozoic nassariids from California have at one time been figured or identified as *N. californianus*. They are: *N. coalingensis* (Arnold), *N. delosi* (Woodring), *N. grammatus* (Dall), *N. iniquus* (Stewart), *N. moranianus* (Martin), and *N. rkinetes* Berry. *Nassarius californianus* is characteristic of marine Pliocene formations from the San Francisco Bay area southward to Santa Maria Basin.

INTRODUCTION

The identity of *Schizopyga californiana* Conrad (1856), the first nassariid gastropod described from Tertiary strata of the Pacific Coast of North America, has been obscured by a cryptic original description and incomplete figure, indefinite locality data, and missing type specimen. Curiously, the name *Nassarius*

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californianus (Conrad) has become widely known by virtue of its continuing, if not consistent, usage in published faunal lists from the later Cenozoic of California. No less than six different species, ranging in age from Pliocene to Recent, have been figured as representing *N. californianus*. These taxa have one principal trait in common, reticulate or papillose ornamentation of the body whorl. Yet they represent three supraspecific groups that are sometimes afforded full generic standing.

It is here concluded that the name *Nassarius californianus* can be fairly confidently fixed on a small Pliocene nassariid whose geologic and geographic occurrence seem to satisfy the vague requirements of the original locality description. As is characteristic of the Cenozoic species of *Nassarius* from the Pacific Coast of North America, *N. californianus* is very useful in stratigraphic correlation.

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TYOLOGY OF *SCHIZOPYGA CALIFORNIANA*

Conrad described *Schizopyga californiana* in 1856 (p. 315) as the only species of *Schizopyga*, a new genus. Subsequently the description was reprinted with a drawing (Conrad, 1857, p. 69, pl. 2, fig. 1) of an incomplete specimen consisting of the penultimate and body whorls but with the outline of the spire restored. The type material, which has been lost, consisted of small samples of sandstone containing abundant specimens of only this species which were collected by a Lieutenant Trowbridge of the U. S. Army from a bed overlying a 3-foot stratum of coal or lignite "12 miles back from Santa Clara" (Newberry, 1857, p. 67). Newberry described the "coal" as lignite and consolidated carbonaceous mud containing a large amount of earthy material. Lignitic material occurs at many places in the lower part of the Santa Clara Formation, a Pliocene and Pleistocene unit composed chiefly of nonmarine gravel and sand. It is not known to be characteristic of other formations in this area. Northeast of the San Andreas fault the Santa Clara Formation crops out in a linear pattern

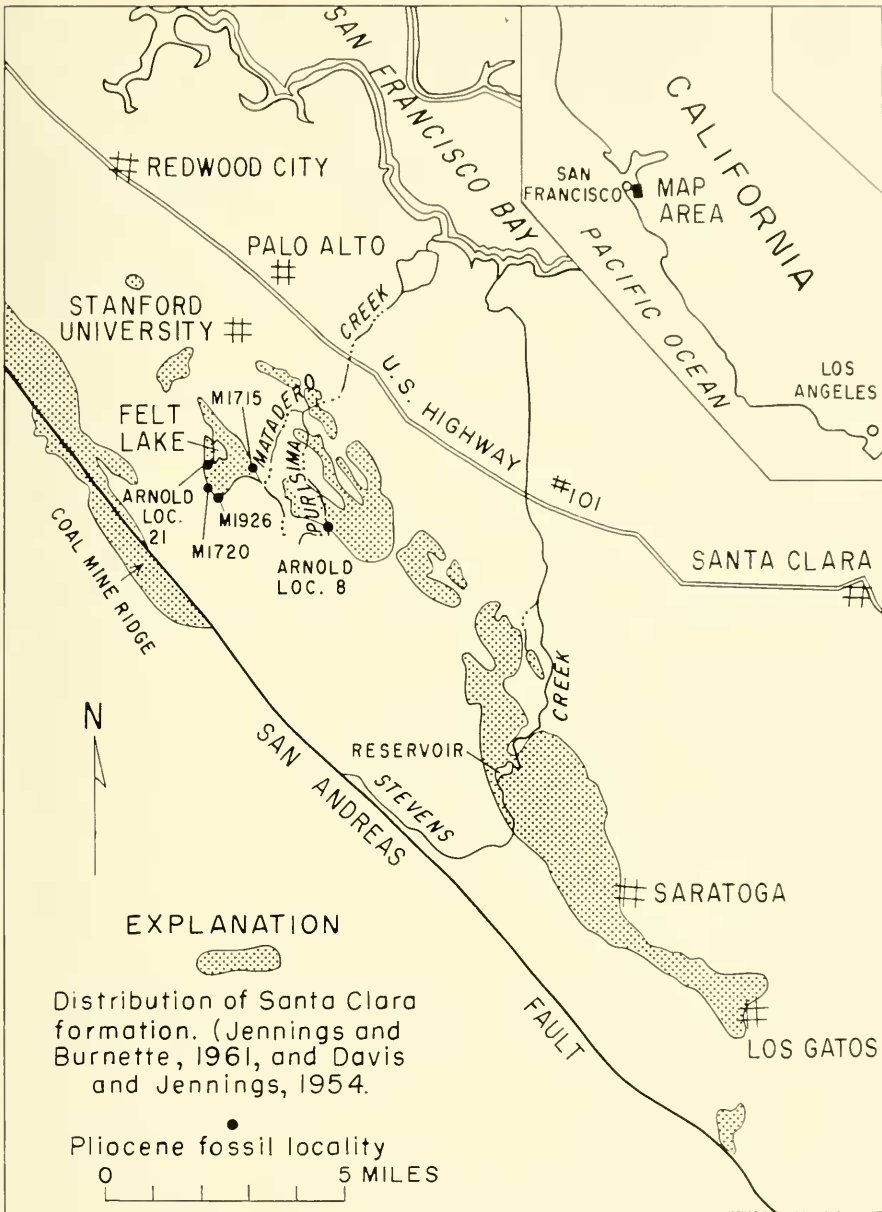


FIGURE 1. Index map of part of San Francisco Peninsula showing distribution of the Santa Clara Formation and localities at which *Nassarius californianus* has been collected from marine strata which interfinger with the basal part of the formation.

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from a point near Los Gatos northwestward to the vicinity of Redwood City (fig. 1), a distance of about 25 miles (Branner and others, 1909; Davis and Jennings, 1954). In the southern part of the belt, lignitic material is locally abundant in road cuts and rock quarries in the basal part of the formation, particularly in the vicinity of Stevens Creek Reservoir (T. W. Dibblee, oral communication, July 1963). It is also characteristic of the basal part of the formation in the vicinity of Coal Mine Ridge, located immediately southwest of the San Andreas fault and about 5 miles south-southwest of Stanford. The presence of lignitic material at the type locality of *N. californianus* suggests that the type material was collected from marine strata which interfinger with the Santa Clara Formation, presumably near the base.

An arc of 12 miles' radius scribed from the present location of the Mission at Santa Clara, California, intersects outcrops of the Santa Clara Formation in two areas: about 2 miles south of Los Gatos and about 3 miles south of Stanford University near Matadero Creek (fig. 1). Marine fossils are not recorded from the first area, although indexes to geologic mapping in California (Strand and others, 1958; Koenig, 1962; and Jennings and Strand, 1963) indicate that it has not been mapped in detail. A rich molluscan fauna of late Pliocene age, including two species of *Nassarius*, is known from several localities in the second area, which is about 12 miles west-northwest of Santa Clara (fig. 1).

The meaning of Newberry's phrase "back from Santa Clara" (1857, p. 67) is not clear. It could imply "back" in the sense of retracing the route from San Francisco, the staging point for the railroad surveys. The fossiliferous exposures south of Stanford seem to fit the description, although no carbonaceous material other than scattered fragments have been found in the Santa Clara Formation in this area (E. Pampeyan, oral communication, August, 1963). Or it could mean directly back from Santa Clara in the Santa Cruz Mountains; if it does, the area of outcrop south of Los Gatos would be a probable location. The abundance of a species of *Nassarius* in marine strata which appear to intertongue with the basal part of the Santa Clara Formation, together with the characteristic occurrence of lignitic material in the basal part of the formation within a 12-mile radius of Santa Clara, suggests that Conrad's material was from this general stratigraphic position. Because of the ambiguity of the original description, it is doubtful that the precise locality will be found.

NASSARIIDS FROM PLIOCENE STRATA NEAR STANFORD, CALIFORNIA

STRATIGRAPHIC OCCURRENCE. Pliocene marine mollusks are known from several localities south of Stanford (fig. 1). Arnold (*in* Branner and others, 1909, p. 6) cited three localities of "characteristic lower Merced fossils" from the southwest side of Felt Lake southeast to Purisima Creek, a distance of about 4 miles. Over the years students from Stanford University have collected additional material from the area south of Felt Lake. New collections have been

made from recent pipeline and building excavations along Arastradero Road west of Matadero Creek and south of Felt Lake. At one of these, U. S. Geological Survey Cenozoic locality M1715 (fig. 1), abundantly fossiliferous poorly consolidated, somewhat gravelly sandstone overlies massive diatomaceous siltstone. The siltstone contains Foraminifera indicative of a late Miocene, Delmontian age (Cummings and others, 1962). A well developed zone of "pholad" pelecypod burrows in the underlying siltstone with the valves preserved, in place, suggests that the contact is unconformable, although there does not appear to be an appreciable difference in attitude between the two stratigraphic units. Conformably overlying the fossiliferous beds along Arastradero Road are unfossiliferous sands and sandy gravels of similar composition referable to the Santa Clara Formation. The gravels are composed of pebbles and cobbles derived from the Franciscan Formation and what appears to be Monterey Shale. The fossiliferous beds are about 10 feet thick in this area. They contain locally abundant concentrations of gravel but seem to have a higher proportion of sand than do the overlying unfossiliferous strata. If two stratigraphic units are to be differentiated, their recognition must depend upon the presence or absence of marine fossils. The fossiliferous sand apparently represents a brief southerly extension of the late Pliocene embayment in which the Merced Formation and correlative marine strata to the north of San Francisco were deposited. It is therefore tentatively referred to the Merced Formation. Following withdrawal of the sea from this area, fluvial sands and gravels of the Santa Clara Formation were deposited. As first noted by Arnold (*in* Branner and others, 1909, p. 6) invertebrates from the localities south of Stanford are comparable to the fauna of the lower part of the type Merced Formation near San Francisco, nearly 30 miles to the northwest. Branner and others (1909), however, included these localities with their underlying Purisima Formation as a convenience in mapping, although the Merced Formation was considered to be the lateral equivalent of the Santa Clara Formation.

COMPARISON WITH CONRAD'S DESCRIPTION AND FIGURE. The Pliocene molluscan fauna consists of nearly 40 species of gastropods and pelecypods. Two species of *Nassarius* occur in this assemblage. The most common (figs. 2-4, 6, 7) is a relatively small slender species with ornamentation and whorl proportions comparable to Conrad's drawing (1857, pl. 2, fig. 1) of *Schizopyga californiana*. The other is a larger species with an inflated body whorl (figs. 8-11), *N. grammatus* (Dall, 1917), which can be readily discriminated from the slender species through all stages of growth. The species of *Nassarius* that was originally described by Conrad can best be determined by comparison with the original figure (Conrad, 1857, pl. 2, fig. 1). The type material is lost (Woodring and others, 1946, p. 74) and the original description, "Volutions rounded, having revolving ribs and longitudinal furrows, giving the ribs a nodulous character:

TABLE 1. Ratio of body-whorl height to combined height of penultimate and body whorls of the two species of *Nassarius* from USGS Cenozoic locality M1715.

Slender <i>Nassarius</i> [<i>N. californianus</i> (Conrad)]				Large <i>Nassarius</i> [<i>N. grammatus</i> (Dall)]			
Penulti- mate whorl	Body whorl	Total	BW/Total	Penulti- mate whorl	Body whorl	Total	BW/Total
2.8 mm.	10.2 mm.	13.0 mm.	0.785	4.8 mm.	25.0 mm.	29.8 mm.	0.845
2.5	9.0	11.5	0.783	4.0	21.0	25.0	0.840
2.6	11.0	13.6	0.809	4.7	22.5	27.2	0.827
2.8	10.9	13.7	0.796	3.7	20.5	24.2	0.848
2.4	9.7	12.1	0.802	5.0	28.1	33.1	0.849
2.9	9.8	12.7	0.771	4.3	27.0	31.3	0.865
2.8	9.8	12.6	0.778	3.4	20.8	24.2	0.864
2.3	9.6	11.9	0.807	3.2	20.1	23.3	0.867
2.6	10.0	12.6	0.794	3.7	23.1	26.8	0.862
2.8	10.8	13.6	0.794	4.0	22.8	26.8	0.852

basal excavation profound" (Conrad, 1856, p. 315), is of little value, as it could apply to either species.

Identification of the slender species (figs. 2-4, 6, 7) as *Nassarius californianus* is suggested by the evenly nodose sculpture, rounded profile and relatively large size of the penultimate whorl, and the rather slender spire, all indicated by Conrad's figure (1857, pl. 2, fig. 1), which is reproduced herein (fig. 5). The ratio of height of the body whorl to combined height of the penultimate and body whorls of the type figure is compared with the ratio of measurements for randomly selected specimens of the two species of *Nassarius* from U. S. Geolog-

FIGURE 2. *Nassarius californianus* (Conrad). Height 13.3 mm., width 7.6 mm. Hypotype, USNM no. 648590. Merced(?) Formation, Pliocene, Santa Clara County, California, USGS Cenozoic loc. M1720.

FIGURES 3, 4. *Nassarius californianus* (Conrad). Height 13.8 mm., width 7.7 mm. Hypotype, USNM no. 648551. Same locality as fig. 2.

FIGURE 5. Reproduction of original figure of *Schizopyga californiana* Conrad (Conrad, 1857, pl. 2, fig. 1). Santa Clara, California, holotype lost.

FIGURE 6. *Nassarius californianus* (Conrad). Height 16 mm., width 8.6 mm. Hypotype, USNM no. 648591. Merced(?) Formation, Pliocene, Santa Clara County, California, USGS Cenozoic loc. M1715.

FIGURE 7. *Nassarius californianus* (Conrad). Height 15.8 mm., width 8.6 mm. Hypotype, USNM no. 648548. Same locality as fig. 6.

FIGURE 8. *Nassarius grammatus* (Dall). Height 27.9 mm., width 17.9 mm. Hypotype, USNM no. 648569. Same locality as fig. 6.



2



3



4



5



6



7



8



9



10



11

FIGURE 9. *Nassarius grammatus* (Dall). Height 33.4 mm., width 21.5 mm. Hypotype, USNM no. 648568. Same locality as fig. 6.

FIGURES 10, 11. *Nassarius grammatus* (Dall). Height 27.6 mm., width 18.2 mm. Hypotype, USNM no. 648592. Same locality as fig. 6.

ical Survey Cenozoic locality M1715 in table 1. The ratio of 0.794 for the type figure falls near the midpoint of the range of values for the slender species, 0.783 to 0.809. The values for the larger species, *N. grammatus*, are appreciably larger, 0.827 to 0.867, and do not overlap with those for the slender species. There are 9 or 10 spiral ribs on the body whorl of the original figure of *N. californianus*. This number compares very closely with the rib count of 9 for the slender species, whereas it is significantly less than the 14 spiral ribs on intermediate and adult specimens of the larger species from locality M1715.

The dimensions of the original figure of *Nassarius californianus* (Conrad, 1857, pl. 2, fig. 1) are about one and one-half times as large as the largest of more than 200 individuals of the slender species from U. S. Geological Survey Cenozoic localities M1715 and M1720 (fig. 1). They are smaller than the average size of about 20 specimens of *N. grammatus* from these localities. If the slender species is identical to Conrad's *N. californianus*, then the type figure must be somewhat enlarged.

Because of the close similarity of many morphological characteristics of the slender species of *Nassarius* with the original figure of *N. californianus*, it is concluded that it is the taxon which Conrad described in 1856 (p. 315) from "Santa Clara, California." That a relatively small specimen of *Nassarius* was the type is suggested by Newberry's description (1857, p. 67) of the original material: "in the small specimens of this rock [sandstone] . . . but a single species of fossil shell is distinguishable, though this is represented by considerable numbers."

Nassarius californianus is common in collections from Pliocene formations in the San Francisco Bay area, Santa Cruz Mountains, Kettleman Hills, and Santa Maria Basin. There are no known occurrences of this taxon in beds younger than Pliocene. In the Kettleman Hills area (Woodring and others, 1940) and the Santa Maria Basin (Woodring and Bramlette, 1950) this species has been known as *N. waldorfensis* (Arnold).

SPECIES CONFUSED WITH *NASSARIUS CALIFORNIANUS*

In 1903, Arnold (p. 231, pl. 4, fig. 3) figured a large coarsely sculptured species with widely spaced axial ribs from upper Pleistocene strata of the San Pedro area, southern California, as *Nassa californiana* (Conrad). Many years later this species was renamed "*Nassa*" *delosi* by Woodring (*in* Woodring and others, 1946, p. 74, pl. 35, figs. 12-15). This is a very rare species once thought to be restricted to beds of late Pleistocene age. Recently, living specimens have been found in southern California near Balboa [Newport Beach] and San Diego (Chace, 1957, 1962).

Other early records of *Nassarius californianus* by Arnold (1908; *in* Branner and others, 1909) from upper Pliocene strata in central California, which include the Felt Lake locality, are of the species later named *N. grammatus* (Dall,

1917, p. 575) (*N. morianus* of authors). A second species of *Nassarius* in Arnold's collections from the Felt Lake locality is Conrad's *N. californianus*. This species appears to have been identified as either *N. mendicus* or *N. perpinguis* by Arnold (1908, p. 355), the only other species of *Nassarius* on his "Merced" faunal list.

A third species from Pliocene strata in the southern San Joaquin Valley figured as *Nassa californiana* by Arnold (1909, pl. 27, fig. 8) was renamed "*Nassa*" *miser iniqua* by Stewart (in Woodring and others, 1940, p. 87, pl. 34, fig. 8). The presence of a varix on the body whorl of this species is a subgeneric characteristic that distinguishes it from *Nassarius californianus*, which has a simple outer lip.

Until recently, Pacific Coast malacologists (Demond, 1952; Abbott, 1954; and others) used the name *Nassarius californianus* for a moderately large species usually occurring at moderate depth in the sublittoral zone (low tide to 100 fathoms) from southern Oregon to the outer coast of Baja California. This usage can be traced to Rivers (1891), who first figured and described a Recent specimen. Dall's figure of *N. californianus* (1921, pl. 11, fig. 4) has been informally recognized as the standard of reference for the living species. Woodring (in Burch, 1945, no. 51, p. 7; and in Woodring and Bramlette, 1950, p. 74) seems to have been the first to recognize that this species was distinct from *N. californianus* (Conrad) and merited a new name. Later, Berry (1953, p. 415-416, pl. 28, fig. 7) proposed the name *N. rhinetes* for the taxon which "has long been known to California students as one of the strange congeries of forms which has passed under the name *Nassa californiana* (Conrad)." Although Dall's (1921, pl. 11, fig. 4) and Demond's (1952, pl. 2, fig. 6) earlier figures were not mentioned by Berry, they very closely resemble his figured specimen.

Nassariid gastropods from the upper part of the type Merced Formation south of San Francisco which have been identified as *Nassarius* cf. *N. californianus* (Glen, 1959, p. 157) probably are immature specimens of *N. morianus* (Martin).

LOCALITY DESCRIPTIONS

U. S. GEOLOGICAL SURVEY CENOZOIC LOCALITY.

- M1715. Cut and pipeline trench on north side of Arastradero Road, 1,200 feet west of intersection with Page Mill Road, Palo Alto 7½' quadrangle, California. Merced(?) Formation, late Pliocene. Collectors: E. H. Pampeyan, J. G. Vedder, and W. O. Addicott, 1963.
- M1720. Cut on south side of highest building site for American Institute for Research buildings on southwest side of Arastradero Road, 2,200 feet due east of intersection with Alpine Road, Palo Alto 7½' quadrangle, California. Collectors: M. D. Crittenden and W. O. Addicott, 1962.

MI1926. About 2,700 feet southeast of intersection of Arastradero and Alpine roads, 400 feet north of lat. $37^{\circ} 22' 30''$ N., 6,000 feet west of long. $122^{\circ} 10' W.$, altitude 650 feet, Palo Alto $7\frac{1}{2}'$ quadrangle, California. Collector: E. H. Pampeyan, 1963.

STANFORD UNIVERSITY LOCALITY.

Arnold No. 8. About $1\frac{1}{2}$ miles southeast of the forks of Page Mill Road (southern intersection of Page Mill and Arastradero roads). Also listed as 2 miles up the east fork of Madera [Matadero] Creek between the "e" and "p" of "Concepcion." Santa Cruz 30' quadrangle, California.

Arnold No. 21. Immediately southwest of Felt Lake, Santa Cruz 30' quadrangle, California. Merced(?) Formation, late Pliocene.

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