

The Northwest American Donacidae

BY

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(1 Plate; 2 Text figures)

INTRODUCTION

THIS IS THE FOURTH ARTICLE based on research conducted while I was a graduate student at Stanford University, the Tellinidae, Semelidae, and Psammobiidae having been discussed in earlier papers (COAN, 1971, 1973a, 1973b). The main purpose of the present account is to put on record data on the systematics of the northwest American Donacidae, those occurring from arctic Alaska to the central portion of the outer coast of Baja California. The present survey also permitted the review of data on the geographic and geologic distributions and habitats of this family. These aspects are summarized at the end of this article.

The major previous accounts on this family in northwestern America were those of STRONG (1924), GRANT & GALE (1931), and BURCH (1945a-1945b). MORRISON (1971) has recently discussed the western Atlantic species.

The detailed "Introduction," "Acknowledgments," and "Methods" sections of my earlier paper on the Tellinidae (COAN, 1971) need not be repeated here, although special thanks are extended to Drs. A. Myra Keen, Warren O. Addicott, and Kenneth J. Boss who reviewed the present manuscript, and to Mr. Barry Roth who prepared the illustrations. The following abridged comments on format and abbreviations will permit the present paper to stand alone.

(1) The applicable synonymous species-level names are listed in chronological order, with the name to be used cited first and "first revisions," if any, indicated. Under each name are listed accounts published using those names and also accounts of type material pertinent to each. These works are listed in chronological order.

The works listed do not represent a complete catalogue of literature but are the major accounts concerning living and fossil northwest American material, particularly those containing previously unpublished information or taxo-

nomic innovations. Not included are books written largely for amateurs or general works on marine biology.

Numbers following dates (as 1851: 27) are page numbers.

(2) The type material pertinent to the valid name and its synonyms is discussed. Measurements given are of the greatest lengths of type specimens. When type material is no longer extant the dimensions from original accounts or of original illustrations are given. (In most early accounts the illustrations were usually printed at natural size, though this was rarely stated.) Photographs of type specimens or of original illustrations are included.

(3) Type localities of the various nominal species are given. The original collector is also cited.

(4) A nomenclatural commentary may be given to explain nomenclatural complications not made clear in the synonymy or in the discussion of type material.

(5) Description. A short diagnosis of each species is given that emphasizes distinguishing characters. Most features of internal shell morphology are not discussed in detail but are illustrated with line drawings.

(6) Geographic Distribution and Ecology. The end-points of the distribution are given, together with reference to the sources of the records. The intermediate distributional data from between these end-points are summarized.

The sources of habitat information on each species other than from museum labels are indicated. I mention also the approximate number of lots examined.

(7) Geologic Distribution and Biogeography. The final section under each species is a summary of paleontologic records from published accounts. I have not listed all Pleistocene records, but generally have given only the end-points of their distributions and indicated the published accounts that form their bases. This is followed by

notes on earlier records, on what seem to be related west American fossil species from earlier than the Pleistocene and other related species in other provinces.

References are included under "Literature Cited" for all genera, species, and papers mentioned.

Conventions, symbols, and abbreviations used are as follows:

- AMNH - American Museum of Natural History, New York, New York
- ANSP - Academy of Natural Sciences, Philadelphia, Pennsylvania
- Berry Collection - The private collection of Dr. S. Stillman Berry, Redlands, California.
- BM(NH) - British Museum (Natural History), London, England
- CAS - California Academy of Sciences, San Francisco, California
- ex (Conrad) MS - from the manuscript name of (Conrad)
- ICZN - International Commission on Zoological Nomenclature, or International Code of Zoological Nomenclature
- "in synonymy"
 - a name proposed in the synonymy of another and therefore not available
- m - meter(s)
- MCZ - Museum of Comparative Zoology, Harvard University, Cambridge, Massachusetts
- mm - millimeter(s)
- not, not of - as in the case of homonyms or misidentifications
- pair - the two valves of one specimen
- SBMNH - Santa Barbara Museum of Natural History, Santa Barbara, California
- SDNHM - San Diego Natural History Museum, San Diego, California
- SU - Stanford University, Stanford, California
- UCB - University of California at Berkeley, California
- UCD - University of California at Davis, California
- USNM - United States National Museum, Smithsonian Institution, Washington, District of Columbia

SYSTEMATIC ACCOUNT

DONACIDAE Fleming, 1828

Within the Tellinacea, the Donacidae and the Psammobiidae retain characters that I regard as being more primi-

tive than either the Tellinidae or the Semelidae, although they retain somewhat different sets of such features.

There are many published studies on the anatomy and functional morphology of members of this family. Most of these are not concerned with west American species and are not reviewed in detail. However, key papers are WHITE (1942), YONGE (1949) (who reviews other earlier papers), PURCHON (1960), STASEK (1963), TRUEMAN (1966), POHLO (1967), and JEGLA & GREENBERG (1968).

The Donacidae may be defined as those Tellinacea that are relatively trigonal, equivalve, and that lack either a posterior flexure or a gape. The ligament is entirely external but not seated on a conspicuous nymph. There are 2 cardinal teeth in each valve and well-developed lateral teeth in the left valve, with corresponding sockets and sometimes lateral teeth in the right valve. The siphons are short and stout.

Donax Linnaeus, 1758

[Type species: *Donax rugosus* Linnaeus, 1758; by subsequent designation of Schumacher, 1817]

Radial sculpture predominates in the genus *Donax*, often present only as marginal crenulations. Attempts to subdivide the species of *Donax* into subgenera described to date prove unsatisfactory, a conclusion reached previously by KEEN (1971).

HERTLEIN & GRANT (1972) suggest *Serrula* Mörch, 1853, ex Chemnitz MS, for *Donax gouldii*, but the species upon which it was based, *D. trunculus* Linnaeus, 1758 (by the subsequent designation of STOLICZKA, 1870), is somewhat inflated anteriorly, smooth within posteriorly, and is said to lack lateral teeth in the right valve (KEEN, 1969).

Paradonax Cossmann, in Cossmann & Peyrot, 1911 (type species: *Donax transversus* Deshayes, 1830, by original designation) might be used as a subgenus for *D. californicus*, although *D. transversus*, unlike *D. californicus*, is said to lack radial sculpture on the ends of the shell (KEEN, 1969).

Donax gouldii Dall, 1921

(Figures 1 to 3 and 7)

Donax gouldii Dall [gouldi, of authors, misspelling]

DALL, 1921: 49 [not described in 1919, as stated]

DALL, 1923: 49

STRONG, 1924: 83-84

I. OLDROYD, 1925: 183; plt. 49, figs. 8, 9

GRANT & GALE, 1931: 380, 906; plt. 13, fig. 12

BURCH, 1945a: 20-21, 24-26 (text figs.); 1945b: 17

GREGG, 1945: 20-21 [in the above]

Donax obesus Philippi, not of d'Orbigny, not of Gould

[not d'ORBIGNY, 1845: 54; 1847: plt. 81, figs. 28 - 30]

PHILIPPI, 1851 (July): 75

[not GOULD, 1851 (November): 90]

Donax obesus Gould, not of d'Orbigny, not of Philippi

[not d'ORBIGNY, 1845: 54; 1847: plt. 81, figs. 28 - 30]

[not PHILIPPI, 1851 (July): 75]

GOULD, 1851 (November): 90

GOULD, 1853: 394 - 395, 408; plt. 15, fig. 9

GOULD, 1862: 212

JOHNSON, 1964: 117

Donax laevigatus Reeve, ex Deshayes MS, not of Gmelin[as *D. "laevigata"*]

[not GMELIN, 1791: 3265]

REEVE, 1854: plt. 5, fig. 31

DESHAYES, 1855: 352

SOWERBY, 1866: 309; plt. 2, figs. 30 - 32

BERTIN, 1881: 66, 91

DALL, 1900: 969

ARNOLD, 1903: 170 - 171, 388; plt. 13, fig. 8

Donax californicus Conrad, of authors, not of Conrad

[not CONRAD, 1837: 254; plt. 19, fig. 21]

GOULD & CARPENTER, 1857: 200

CARPENTER, 1857a: 213

CARPENTER, 1857b: 195 - 196, 227, 229, 232, 241, 246, 287, 296, 304, 349, 351, 352

CARPENTER, 1857c: 47, 548

CARPENTER, 1864: 536, 540, 640, 665 [1872: 22, 26, 126, 151]

RÖMER, 1870: 41 - 43; plt. 4, figs. 5 - 8

Donax abruptus Carpenter, ex Gould MS [in synonymy]

CARPENTER, 1857b: 232

CARPENTER, 1864: 542 [1872: 28]

Type Material:

Donax gouldii - USNM 664935, holotype, pair, 23.2 mm. Dall's taxon was based on GOULD's (1853) figures; thus the figured specimen is the holotype. Figure 1.

Donax obesus Philippi - Lost, according to Drs. Kiliyas and Tembrock of the Zoologisches Museum, Humboldt Universität, Berlin (in correspondence), 20.7 mm (PHILIPPI, 1851). The description is sufficient to place this taxon in synonymy.

Donax obesus Gould - USNM 664935, lectotype herein, pair, 23.2 mm; USNM 664936, paralectotypes, 5 pairs. Figure 1.

Donax laevigatus - BM(NH), without registry number, lectotype herein, pair on extreme left on card, 23 mm; paralectotypes, 2 other pairs. Figure 2.

Type Localities:

Donax gouldii and *D. obesus* Gould - San Diego, California; T. P. Green.

Donax obesus Philippi - California; "from a dealer."

Donax laevigatus - North America; Cuming collection (DESHAYES, 1855).

Nomenclatural Commentary:

This common southern Californian species has suffered a complicated nomenclatural past.

Two names proposed for it have proved to be junior homonyms - *Donax obesus* (proposed twice, independently!) and *Donax laevigatus*. It was finally named *Donax gouldii* by DALL (1921), but Dall did not expressly propose his taxon as a replacement, so *Donax gouldii* must be regarded as a new species. As such, it is based on the specimen figured by GOULD (1853), for DALL (1921) cited this figure. This specimen came to light in the course of the present study.

Nuttall evidently never correctly understood what it was from among his material Conrad had described as *Donax californica*, and he labeled the specimens of *D. gouldii* that he took to Europe (Figure 3) as *D. californica*. This is the reason that Carpenter and others also became confused and used the name *D. californica* for the wrong species.

GREGG (1945), JOHN Q. BURCH (1945a) and TOM BURCH, in JOHN BURCH (1945a), suggested that there are two distinct forms of this species which occur in "pure" colonies.

One form, the true *Donax gouldii*, was characterized by these authors as being short, rounded posteriorly, obese, and almost lacking in radial color rays. It is supposed to be more southern in distribution (San Diego, California, to Bahía Todos Santos, Baja California Norte).

The second, unnamed but still more common, was characterized as being more elongate, squarely pointed anteriorly, with conspicuous radial color rays. It is supposed to occur farther north in southern California (as at San Pedro) but also to occur as far south as Bahía Todos Santos.

Two illustrations accompany the text (first form, figure "MS 4411"; second, "MS 4410"), and TOM BURCH in JOHN BURCH (1945a), said that these illustrate hinge differences not discussed in the text. It is difficult to detect any significant differences, but perhaps the first form is supposed to differ from the second in having a longer ligament, heavier laterals, and a less delimited posterior adductor muscle scar.

An examination of specimens in the California Academy of Sciences does not demonstrate any of these differences. For instance, some short, obese specimens (CAS 4878) have conspicuous radial rays. Hinge differences of the sort suggested are not apparent.

It is more likely that these differences represent character patterns associated with habitat. The short, obese form may be typical of populations on exposed beaches, while the more elongate form may represent those from semi-protected, bay entrance locations.

Description:

Medium-sized for genus (to 31.5 mm); ovate; inflated; relatively heavy; anterior end markedly longer, rounded; posterior end abruptly truncate; ventral edge evenly rounded to slightly flexed posterior to beaks; surface relatively smooth, shiny, but with obscure, underlying radial sculpture; periostracum thin, shiny; shell often rayed, banded, or blotched with brown, tan, blue, or other colors; interior ventral margin roughened by ends of radial sculpture. Other internal details as in Figure 7.

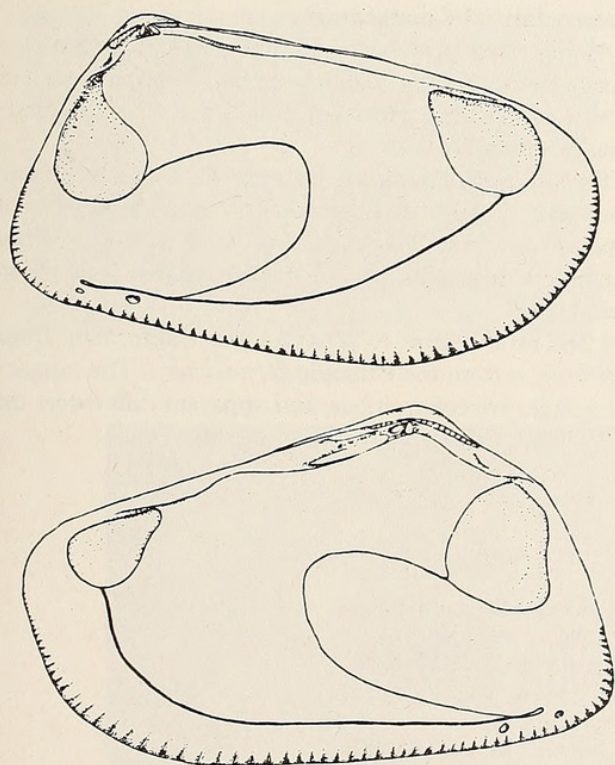


Figure 7

Donax gouldii

internal view of valves, SU 50, Long Beach, California

Geographic Distribution and Ecology:

Dillon Beach, Tomales Bay, California (HEDGPETH, *in* MARCUS, 1961: 58); Davenport, California (collection of Mrs. Charles McLean); Monterey, California (MCZ 118780; AMNH 32896; ANSP 225910); San Luis Obispo-Pismo Beach area, California (UCD unnumbered; SDN HM 20042; SBMNH 10666) to Bahía Magdalena, Baja California Sur (USNM 41592; ANSP 52962; SDNHM 14976). Records from north of the San Luis Obispo area, California, probably represent larval settlement in particularly warm years. It is common between San Luis Obispo and Bahía Magdalena. Specimens in collections reportedly from Mazatlán, Sinaloa (SU 50/3), and from the Gulf of California (UCB 2404) probably represent labeling errors.

This filter feeding species occurs intertidally, but occasionally as deep as 5 m, in sand, mainly on open beaches, but also in semi-protected environments near bay entrances. The favored habitat is reported to be gently sloping beaches composed of firm, fine sand (WEYMOUTH, 1921; FITCH, 1953; COE, 1955; JOHNSON, 1966a, 1966b; POHLO, 1967; IRWIN, 1973).

Most individuals align themselves along the coast, broadside to the waves. Unlike other species of *Donax*, migration up and down the beach (as opposed to along) is minimal. Many specimens have colonies of the hydroid *Clytia bakeri* Torrey, 1904, attached to their posterior slopes.

This species occurs in very large numbers, sometimes as many as 20 000 to 32 000/m² (COE, 1953, 1955; POHLO, 1967). Population size fluctuates greatly from year to year, evidently caused in part by parasitic infections. Individuals can live up to 3 years, and spawning occurs from April to October or November (COE, 1955). Internal morphology and behavior were discussed by POHLO (1967), and IRWIN (1973) treated several aspects of behavior.

Material seen:

221 lots.

Geologic Distribution and Biogeography:

Donax gouldii has been reported in the late Pleistocene from Santa Monica, California (HOOTS, 1931; VALENTINE, 1956), to Bahía Magdalena, Baja California Sur (JORDAN, 1936), with many intermediate records. In the early Pleistocene it is reported from the northern portion of the Los Angeles Basin (RODDA, 1957) and from the San Pedro area (ARNOLD, 1903; CLARK, *in* NATLAND, 1957), California. This species is also known from formations transitional between the Pliocene and the Pleistocene (ARNOLD, 1903; WATERFALL, 1929), and it has

recently been recorded from the Pliocene (HERTLEIN & GRANT, 1972). Its relationship to species reported from the west American Eocene to Miocene is unclear, as are its alliances to species living in the Panamic province or in Japan.

Donax californicus Conrad, 1837

(Figures 4, 5?, 6, and 8)

Donax californicus Conrad, but not that of some authors

[as *D. "californica"*]

CONRAD, 1837: 254; plt. 19, fig. 21

BERTIN, 1881: 66, 92

DALL, 1900: 968 - 969

ARNOLD, 1903: 170, 388; plt. 8, fig. 9

DALL, 1921: 49

DALL, 1923: 49

STRONG, 1924: 81 - 83

I. OLDROYD, 1925: 183

GRANT & GALE, 1931: 379 - 380

BURCH, 1945a: 20; 1945b: 17

HERTLEIN & STRONG, 1949: 252 - 253, 258; plt. 1, figs. 2, 5

KEEN, 1971: 235 - 236; text fig. 584

HERTLEIN & GRANT, 1972: 302 - 303

?*Donax naviculus* Hanley [as *D. "navicula"*] [probably a synonym]

HANLEY, 1845: 15

REEVE, 1854: plt. 4, fig. 18

CARPENTER, 1857b: 186, 229, 246, 279, 304

CARPENTER, 1857c: 50

CARPENTER, 1864: 537, 541, 620, 640 [1872: 23, 27, 106, 126]

SOWERBY, 1866: 314; plt. 3, fig. 80

BERTIN, 1881: 66, 97

HERTLEIN & STRONG, 1949: 254, 258; plt. 1, fig. 1

OLSSON, 1961: 341, 533; plt. 60, figs. 3, 3a

KEEN, 1971: 237 - 238; text fig. 593

Type Material:

Donax californicus - Lost, but CONRAD's (1837) description and 23 mm-long figure are sufficient to identify the taxon. Twelve specimens in BM (NH) Nuttall collection 61.5.20.91 (Figure 3), thought by Nuttall, Carpenter, and KEEN (1966: 170) to have been the type material, are really *Donax gouldii* Dall, 1921. Conrad's figure: Figure 4.

Donax naviculus - BM(NH), without registry number, **lectotype** herein, the larger of 2 specimens, pair, 24.5 mm; **paralectotype**, a smaller right valve. Figure 5.

Type Localities:

Donax californicus - Near Santa Barbara, California, in sand; T. Nuttall.

Donax naviculus - Golfo de Nicoya, Costa Rica; H. Cuming.

Nomenclatural Commentary:

As discussed previously, due to a misinterpretation of type material, *Donax gouldii* went under the name *D. californicus* for a time. However, this is not the only nomenclatural complication.

Perhaps in an attempt to interpret Conrad's type figure, SOWERBY (1866) used the name *Donax californicus* for what we now call *Donax contusus* Reeve, 1854, a distinct Panamic species with pits in the interspaces between the radial ribs.

I see little reason to separate the Californian *Donax californicus* from the Panamic *D. naviculus*. The ranges of the species are coterminous, and apparent differences may

Explanation of Figures 1 to 6

Figure 1: *Donax gouldii*. Holotype of *Donax gouldii* and **lectotype** (herein) of *Donax obesus* Gould, USNM 664935; 23.2 mm

Figure 2: *Donax gouldii*. **Lectotype** (herein) of *Donax laevigatus* Reeve, specimen on left, BM(NH) without registry number; 23 mm. The two specimens on right are **paralectotypes**

Figure 3: *Donax gouldii*. Specimen in Nuttall collection, BM(NH) 61.5.20.91, labeled "*Donax californica* Conr."; card measures 72 mm across

Figure 4: *Donax californicus*. Conrad's original illustration; 23 mm

Figure 5: *Donax naviculus* (? = *D. californicus*). **Lectotype** (herein) of *Donax naviculus*, BM(NH), without registry number; 24.5 mm

Figure 6: *Donax californicus*. Hypotype, CASGTC 53333, San Pedro, California; 23.5 mm

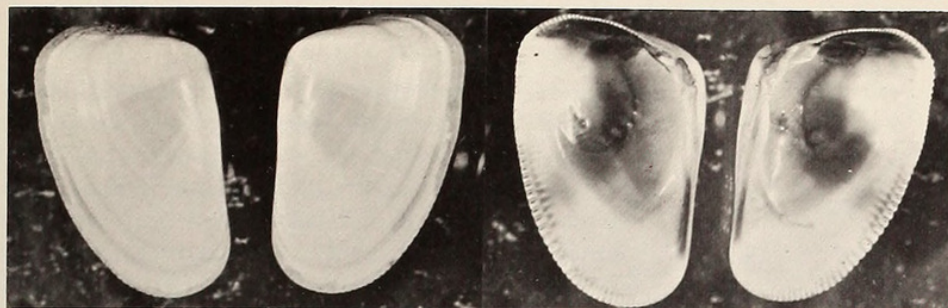


Figure 1

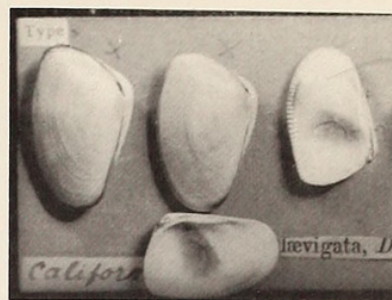


Figure 2

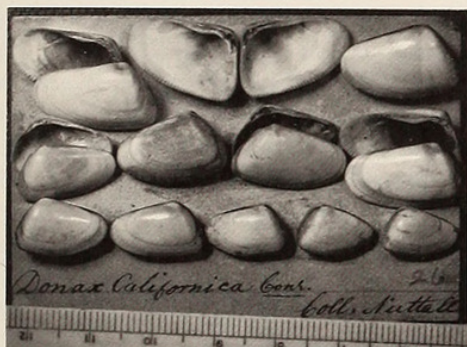


Figure 3

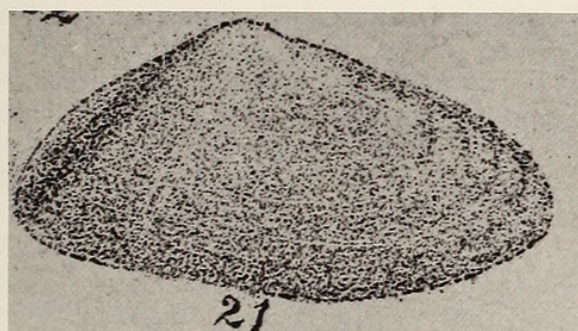


Figure 4

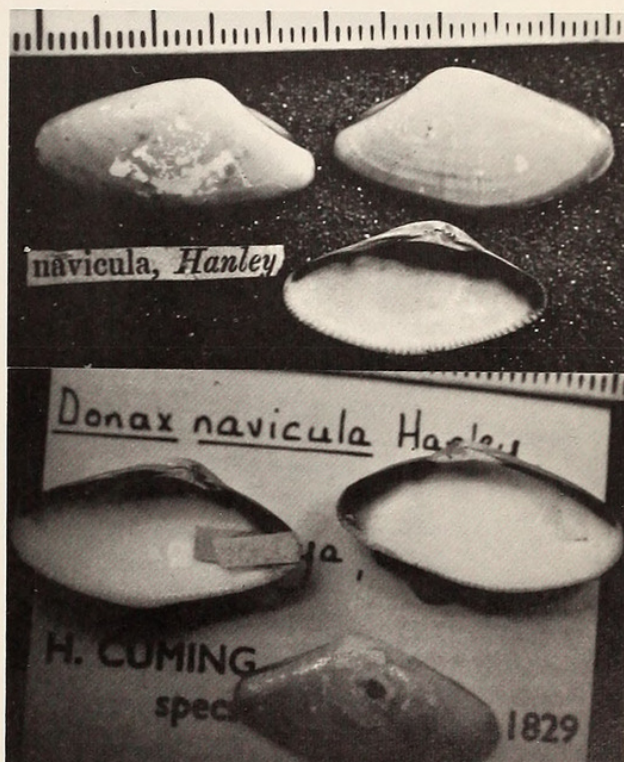


Figure 5

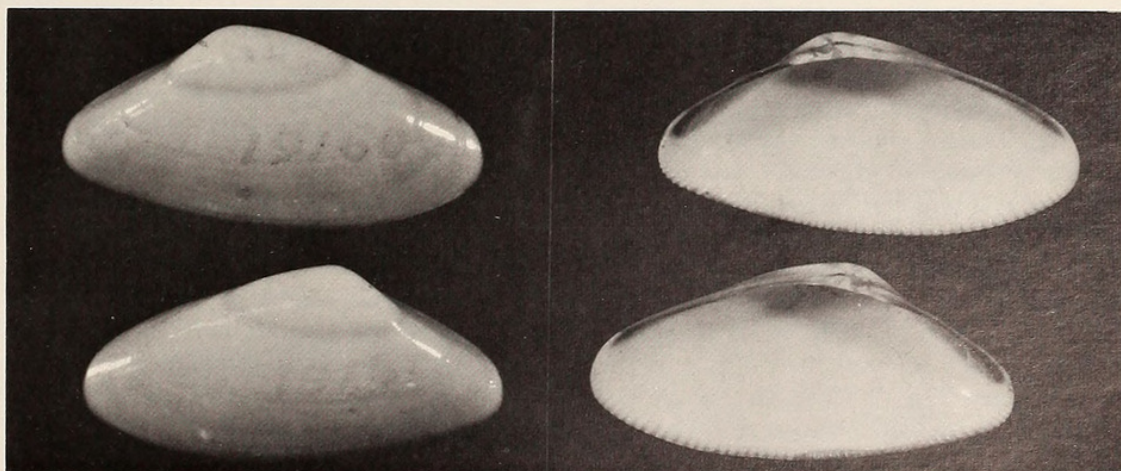


Figure 6

be clinal. Panamic material averages larger, is more triangular, and is more concave postero-dorsally. HANLEY (1845), in fact, compared *D. naviculus* to *D. californicus*, indicating that the former was "more triangular." A statistical study is needed to elucidate properly the relationship between the two taxa. In the meanwhile, Californian records of *D. naviculus* (CARPENTER, 1864: 640; and COOPER, 1867) may be dismissed and the name restricted to material from south of Bahía Magdalena, Baja California Sur.

Donax flexuosus Gould, 1853, was described from "Santa Barbara," California, but this was in error. The type specimens are, in reality, *D. striatus* Linnaeus, 1767, from the Caribbean, and a lectotype has been designated and illustrated by JOHNSON (1964). Perhaps because of the use of the name *D. californicus* for the wrong Californian species and a "process of elimination," the name *Donax flexuosus* was used by some workers (COOPER, 1867, 1888; WILLIAMSON, 1892) for the true *D. californicus*.

CARPENTER (1857b) reported the similar species *Donax gracilis* Hanley, 1845, from California based on Jewett's collection. Later (1864), he suggested that the specimens were probably from the Panamic province. *Donax gracilis* is not known from north of Bahía Magdalena, Baja California Sur (KEEN, 1971), and is characteristic of more open coast than *D. naviculus* (HOFFSTETTER, 1952). It is longer, narrower, more evenly curved ventrally, less inflated, and more shiny than *D. naviculus* (OLSSON, 1961; KEEN, 1971).

Description:

Medium-sized for genus (to 25 mm, but up to 33 mm); elongate; moderately inflated; relatively thin; anterior end longer, produced, rounded; bluntly pointed posteriorly; ventral edge evenly rounded to flexed a little anterior to beaks; surface relatively smooth, shiny, but with faint radial sculpture; periostracum thin, adherent, tan, shiny; dorsal margins rayed with dark stripes; interior ventral margin roughened by ends of radial sculpture. Other internal details as in Figure 8; see also Figure 6.

Geographic Distribution and Ecology:

Santa Barbara, California (CONRAD, 1837, but not collected in recent years); Point Mugu, California (USNM 348175), to Bahía Magdalena, Baja California Sur (MCZ 71141; ANSP 225916; and many other lots), with many intermediate records; presumably to Tumbes, northern Peru (OLSSON, 1961), if *Donax naviculus* is ranked as a synonym or subspecies. This species occurs from the intertidal zone to 5 m, in sandy mud, in protected environments such as near bay or estero entrances (WEYMOUTH, 1921; BURCH, 1945a; FITCH, 1953).

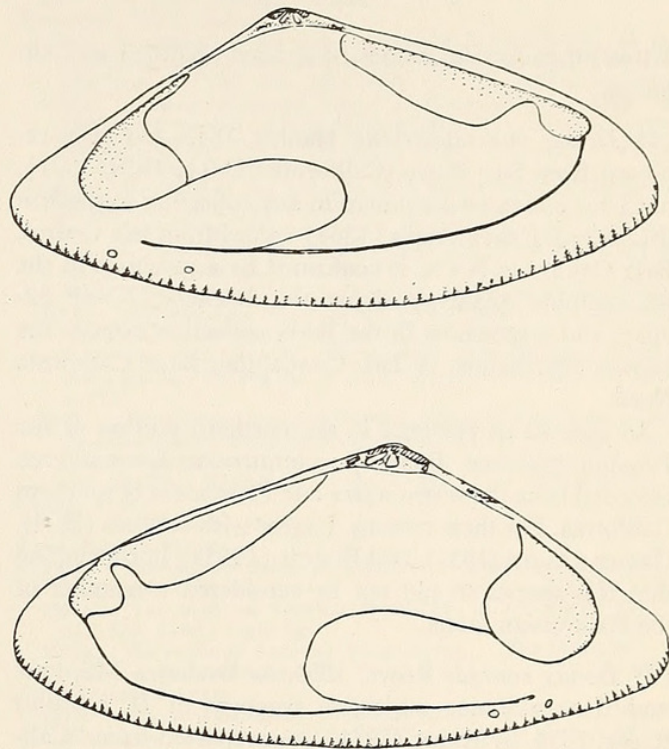


Figure 8

Donax californicus

internal view of valves, SU 51, San Pedro, California

Material seen:

92 lots from north of Bahía Magdalena.

Geologic Distribution and Biogeography:

In the late Pleistocene, *Donax californicus* is known from the Baldwin Hills, California (WILLETT, 1937; BURCH, 1947), to Bahía Magdalena, Baja California Sur (JORDAN, 1936). (*Donax naviculus* has been recorded from the late Pleistocene of Santa Elena, Ecuador, by HOFFSTETTER [1952]). It has also been reported in the early Pleistocene of the San Pedro area, California (ARNOLD, 1903; T. OLDROYD, 1925; BURCH, 1947), and from a transitional Plio-Pleistocene formation of southern California (PRESSLER, 1929). Records of this species from the Pliocene of San Diego, California (COOPER, 1888 [as *D. flexuosus*]; DALL, 1900) have not been confirmed in recent years (HERTLEIN & GRANT, 1972).

Thus, it appears that *Donax californicus* may be an early Pleistocene arrival to our fauna and presumably of Panamic origin.

OTHER SPECIES

Three other specific names have been recorded as Californian:

(1) *Donax punctatostriatus* Hanley, 1843, has been reported from San Pedro, California (DALL, 1916, 1921), but I have seen no specimens in any collection to confirm this record. CARPENTER's (1864) record from Isla Cedros, Baja California Norte, is confirmed by a specimen in the Philadelphia Academy of Natural Sciences (ANSP 52-963), and a specimen in the Berry collection extends the known distribution to Isla Guadalupe, Baja California Norte.

In spite of its presence in the northern portion of the Panamic province, *Donax punctatostriatus* has not been recorded from the warm water late Pleistocene of southern California. For these reasons, I agree with STRONG (1924), GRANT & GALE (1931), and BURCH (1945a) in concluding that this species should not be considered a member of the Californian fauna.

(2) *Donax conradi* Reeve, 1854, *ex* Deshayes MS, now ranked as a junior subjective synonym of *D. contusus* Reeve, 1854, by KEEN (1971), was reported from "California" by DESHAYES (1855) and from San Pedro, Cali-

fornia, by DALL (1916, 1921). Deshayes' record was simply lack of precision. Dall's record probably was in error since there are no specimens from California in any of the collections I have examined. *Donax contusus* occurs only as far north as the southern part of the Gulf of California (KEEN, 1971). The conclusion to exclude this species from the Californian province was also reached by STRONG (1924), GRANT & GALE (1931), and BURCH (1945a).

(3) *Donax rostratus* C. B. Adams, 1852a, was reported from Santa Barbara, California, by CARPENTER (1857b) based on the Jewett collection. Later he noted that these specimens were actually from Acapulco, Mexico (CARPENTER, 1864).

ECOLOGY AND BIOGEOGRAPHY

So that they may be compared with information published for the 3 other tellinacean families, the ecological data about the two species of northwest American Donacidae are summarized as follows:

Table 1

Species	Depth range meters	Bottom type	Coastal exposure
<i>Donax gouldii</i>	0 - 5	fine sand	exposed to semi-protected
<i>Donax californicus</i>	0 - 5	sandy-mud	protected

The relative abundance of the two species is reflected in their frequency in museum collections:

Table 2

Species	Number of lots seen
<i>Donax gouldii</i>	221
<i>Donax californicus</i>	92 ¹

¹ not including specimens from Panamic province south of area of study (assuming *D. naviculus* is a synonym)

Defining the boundary between the Oregonian and Californian provinces as Point Conception, California, and that between the Californian and Panamic provinces as Punta Eugenio, Baja California Sur, the faunal relationships of the two species may be indicated as follows:

Table 3

Oregonian	Californian	Panamic
3. <i>Donax gouldii</i>	2. <i>Donax californicus</i>	= ? <i>D. naviculus</i>

In this table, the following abbreviations are used:

2. species occurring in 2 provinces
3. species occurring in 3 provinces

Reported distributions in the late Pleistocene are similar to distributions in the Recent fauna. *Donax gouldii* appears in the Pliocene, while *D. californicus* is first known from near the Plio-Pleistocene boundary. The relation of both to earlier species remains unclear. The affinity of *D. californicus* to Panamic species is certain, while the biogeographic relations of *D. gouldii* are unknown.

Literature Cited

[All works cited in the text, including sources of taxonomic units, are listed. Volume, bulletin, monograph, memoir, professional paper, and special paper numbers are in bold face; series numbers, in parentheses, precede volume numbers; issue numbers, in parentheses, follow volume numbers; supplementary information, such as secondary methods of listing volumes, part numbers, and parenthetical statements, are given in brackets. Plates, portraits, text figures, maps, and charts are listed, but not tables. Exact publication dates are given when possible.]

ADAMS, CHARLES BAKER

1852a. Catalogue of shells collected at Panama, with notes on synonymy, station and habitat. . . . Lyc. Nat. Hist. New York, Ann. 5: 229-296 (June); 297-549 (July) reprinted:

1852b. Catalogue of shells collected at Panama, with notes on their synonymy, station, and geographical distribution. New York (Craighead) viii+334 pp. [see also TURNER, 1956]

ARNOLD, RALPH

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