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CHROMOSOMES OF THE SUCCINEID SNAIL *CATINELLA ROTUNDATA*[1]

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PUBLISHED reports of haploid chromosome numbers of the "pulmonate" land snails (Euthyneura, Stylommatophora) indicate that the numbers range from n=17 to 34 (Fig. 1). The Succineidae, to which *Catinella rotundata* (Gould, 1848) belongs, has the lowest haploid numbers recorded for any pulmonate species, which, until this report, was 17. This number (n=17) was found in three species of Japanese succineids by Inaba (1945) and Koyama (1955). With the exception of these three species, the break in the ranges of chromosome numbers between the land and the aquatic "pulmonates" seemed so sharp as to draw special note by cytologists studying the groups (Inaba, 1959; Burch and Heard, 1962). The aquatic "pulmonates" (Order Basommatophora), except for the polyploid species (see Burch, 1960 *a, c*, 1964; Burch, Basch, and Bush, 1960), all have fewer than 20 pairs of chromosomes. Nearly all of the land stylommatophoran "pulmonates" seemed to have 20 or more pairs of chromosomes (Burch, 1960 *b*; Burch and Kim, 1962; Inaba, 1959).

In view of the much higher numbers so far known to occur in the Succineidae, but especially in the other stylommatophoran families, it was quite unexpected to find a succineid land snail that had only five pairs of chromosomes. It is on this species, *Catinella rotundata*, that the present paper is based.

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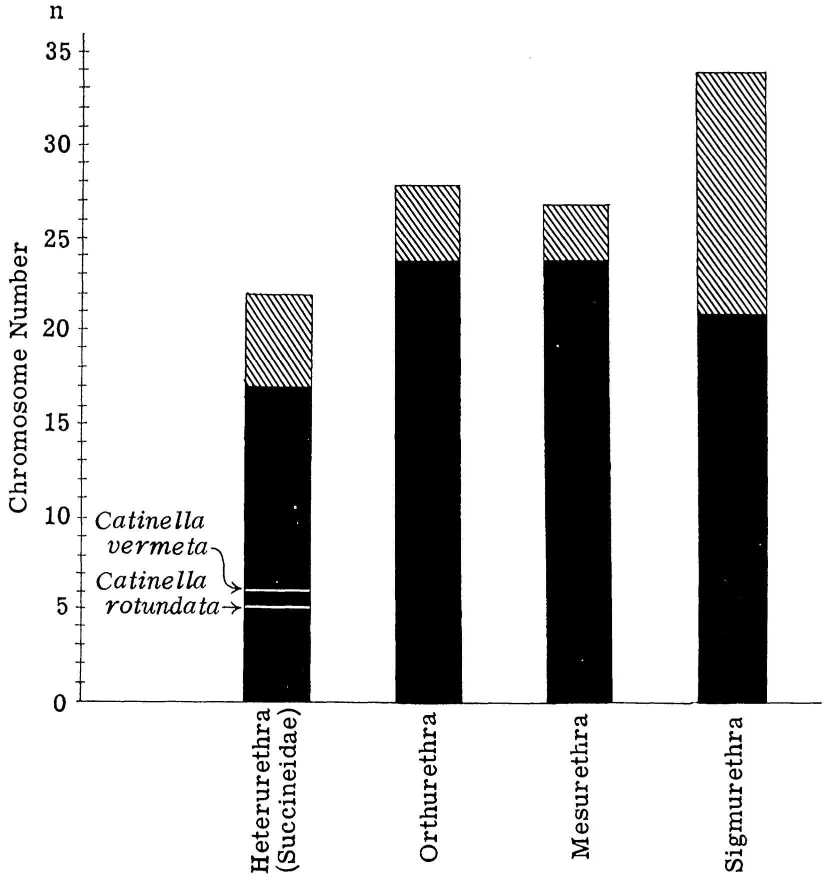


FIG. 1. Haploid chromosome numbers reported for stylommatophoran snails. Shaded areas represent extent of variation in haploid numbers as determined by previous reports. From Inaba, 1960; Burch and Kim, 1962; Burch and Heard, 1962; Husted and Burch, 1946, 1953; Perrot, 1937, 1938.

SYSTEMATICS

The family Succineidae, which comprises the "amber snails," has a world-wide distribution. Shells of the species offer few characters which help in their classification and accordingly succineid systematics has lagged behind that of many other land snail groups. Recent anatomical studies (Quick, 1933, 1934, 1936, 1939 *a*, *b*; Boettger, 1939; Pilsbry, 1948; Odhner, 1950) have considerably improved systematics within the family, but much critical work remains to be done in order to establish a completely satisfactory classification.

Quick (1933) divided the family into two main groups which are distinguished by the presence or absence of a penial sheath. Odhner (1950) gave these two groups formal subfamily names: Succineinae for the group with a penial sheath, Catinellinae for the group without the sheath. He thought that the subfamily Catinellinae contained the most primitive species of the two, and divided it into three genera: *Catinella* Pease, 1871, the most specialized, *Quickia* Odhner, 1950, intermediate, and *Indosuccinea* Rao, 1924, the most primitive of the three genera.

Odhner (1950) recognized three subgenera within the genus *Catinella*: *Catinella s.s.*, *Quickella* Boettger, 1939, and *Mediappendix* Pilsbry, 1948. It is difficult to ascertain which subgenus should be considered the more primitive. Because of the relative lengths (i.e., nearly equal) of the spermathecal duct and the penis, *Catinella s.s.* might be considered the more specialized, but its shorter vagina and simple penis (without an appendix) are strong indications that it should be placed in a more primitive position.

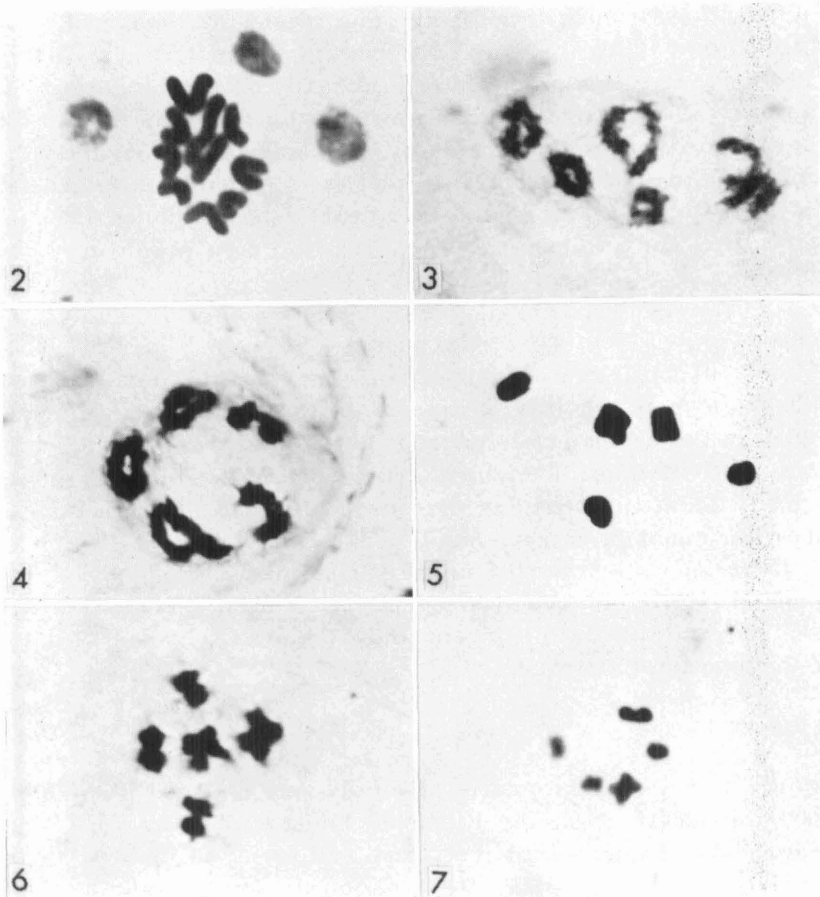
Catinella s.s. is restricted to the Pacific islands, *Mediappendix* is found in North America, and *Quickella* occurs in western Europe. The species treated in the present study, *Catinella rotundata,* belongs to the subgenus *Catinella s.s.*

MATERIALS AND METHODS

The four specimens used in this study were obtained from about 2000 feet elevation on the Paomoho Trail, Koolau Range, Oahu, Hawaii. The tissues were killed, fixed, and preserved in Newcomer's (1953) fluid and stained by the acetic-orcein squash technique (La Cour, 1941). Observations were made with Nikon (Nippon Kogaku) microscopes using 100 × (n.a. 1.25) oil immersion objectives and 10 × and 30 × oculars. The chromosomes were drawn with the aid of a camera lucida and reproduced at a table top magnification of 5700 ×. Photographs were taken using a 10 × ocular, oil immersion objective, a Kodak Wrattan 57A (green) filter, and Kodak High Contrast Copy film.

OBSERVATIONS

The diploid number for *Catinella rotundata* is 10. The five pairs of chromosomes can be discerned quite readily in the spermatogonial cells (Figs. 2, 8, 9). All of the mitotic chromosomes are medianly constricted, or very nearly so, and are rather large in comparison with those of other stylommatophoran snails. The largest spermatogonial



FIGS. 2–7. Chromosomes of *Catinella rotundata*: 2, spermatogonial Metaphase; 3 and 4, diakinesis; 5, Metaphase I; 6, late Prophase II; 7, dyads at one pole of a cell at Telophase I. All figures are of stages of spermatogenesis and all are magnified × 1930. Figs. 2, 4, and 6 are photographs taken from a temporary slide. Figs. 3, 5, and 7 are photographs taken from a permanent slide.

chromosome measured was 6.0 micra long, the smallest chromosome of the same cell was 3.2 micra long.

In all major stages of both divisions of meiosis, i.e., prophase, metaphase, anaphase, and telophase, five pairs of chromosomes or five chromosomes can easily be observed. During the diakinesis of Prophase I the chromosomes appear as closed or open circles of varying sizes or as crosses (Figs. 3, 4, 10). Presumably each of the closed ring-shaped bivalents has two chiasmata, and each of the open rings or

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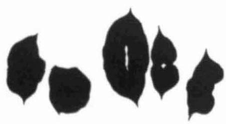

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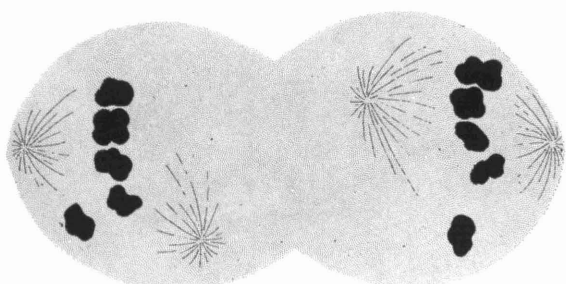

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FIGS. 8–14. Camera lucida drawings of chromosomes of *Catinella rotundata*: 8 and 9, spermatogonial Metaphase (Fig. 8 is a camera lucida drawing of the photographed chromosomes in Fig. 2); 10, drawing of chromosomes shown in Fig. 3; 11, Metaphase-Anaphase I (side view); 12, drawing of bivalents shown in Fig. 5; 13, drawing of dyads shown in Fig. 7; 14, Metaphase II. All figures are of stages of spermatogenesis and all are magnified × 1930. Figs. 8, 9, 11, and 14 were drawn from a temporary slide; Figs. 10, 12, and 13 were drawn from a permanent slide.

crosses has only one. The most common configuration of bivalents found during diakinesis was four circles and a cross (Figs. 3, 10); less frequent were five circles or three circles and two crosses.

The chromatin of the Metaphase I bivalents is more condensed, giving the bivalents a smoother appearance (Figs. 5, 12). A side view of Metaphase-Anaphase I bivalents is shown in Figure 11. The length of the largest bivalent here is 5.8 micra. The Telophase I and Metaphase II dyads are noticeably smaller than the Metaphase I bivalents of adjacent or nearby cells (compare Fig. 11 with Fig. 14, and Fig. 12 with Fig. 13; Figs. 11 and 14 can not be compared with Figs. 12 and 13 because the two slides were treated differently at the time the illustrations were prepared, i.e., one was temporary and the other permanent).

DISCUSSION

The chromosome numbers of *Catinella rotundata* (n=5, 2n=10) of Hawaii are the lowest yet reported for a mollusk. The previously lowest number reported for a land snail was n=17 for three Japanese succineids. However, I have found that *C.* (*Mediappendix*) *vermeta* of Michigan, U.S.A., has six pairs of chromosomes, and thereby has only one more bivalent than *C. rotundata*. The fact that the two members of the genus have nearly the same chromosome number, although widely separated geographically and belonging to two different subgenera, points to a cytological conservatism in gastropods that has been demonstrated in numerous other groups (see Burch, 1961).

An additional point in connection with the low chromosome numbers of *C. rotundata* and *C. vermeta* is that morphologists (see Odhner, 1950; Pilsbry, 1948) consider *Catinella* to be the most primitive of the succineid genera. They certainly have the lowest chromosome numbers of any succineid for which chromosome data are available. This is in accord with previous observations on chromosome number changes in euthyneuran snails (see Burch, 1961), i.e., that increased specialization in snails has been accompanied by a tendency for increase in chromosome number and decreases in chromosome numbers appear to be rare. In lower systematic categories in the Stylommatophora, higher chromosome numbers go with the more highly specialized species, lower numbers with the less specialized species. Husted and Burch (1946, 1953) were the first to suggest that such a relationship between chromosome numbers and morphological characters might occur in "pulmonate" gastropods.

If the directional increase in chromosome numbers mentioned above holds true in all cases, one would expect that the subgenus *Catinella s.s.* (with n=5 for *C. rotundata*) is more primitive than the subgenus *Mediappendix* (with n=6 for *C. vermeta*). Because of its short vagina and simple penis, both considered primitive characters, *Catinella* s.s. is indeed considered the more primitive of the two subgenera. It will be interesting to study the chromosomes of *C. arenaria* of the European subgenus *Quickella* which, on account of its less specialized penis, would seem to be less advanced than *Mediappendix* (but more advanced than *Catinella s.s.*). But of especial interest would be a study of the two other catinelline genera, *Quickia* and *Indosuccinea,* which Odhner (1950) considers even more primitive than *Catinella.*

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