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SOS NATS

## A new class of Echinodermata from New Zealand

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During examination of echinoderms from sunken wood collected from depths between 1,057 and 1,208 m off the New Zealand coast, we discovered nine specimens of a small flattened discoidal invertebrate. These animals, briefly described here, superficially resemble a cnidarian medusa, but their pentamerous morphology is distinctly echinoderm-like. We consider that the features of these newly discovered echinoderms warrant the recognition of a new class. *Xyloplax medusiformis* n.gen. and n.sp. represents a radical departure in morphology from any other known extant echinoderm. Its obvious tube feet, clearly pentamerous body pattern, and calcite skeleton leave no doubt that the animal is an echinoderm. However, its concentrically arranged skeletal structures and single series of tube feet arranged in a ring are novel. The water vascular system of *Xyloplax* consists of a double ring of canals which service the tube feet in inter-radial positions; in all other living echinoderms the vascular ring (circum-oral) is single, and the tube feet are serviced from it in radial positions. These specimens represent the first new class of living echinoderms to be described since 1821. A full description of the new taxon is in preparation.

### Class Concentricycloidea nov.

**Diagnosis:** A free-living echinoderm characterized by a weakly inflated disk-shaped body, without mouth, anus or radiating arms. Its water vascular system, including tube feet, and supporting skeletal structures are arranged concentrically on the ventral surface. The water vascular canals form a double ring with inter-radial connections to the tube feet; the ventral surface is covered by a complete velum.

**Etymology:** *concentricus* and *cylus* are Latin for 'concentric' and 'ring', respectively, alluding to the double water vascular ring and the concentric skeletal structures.

Order Peripodida nov.

Family Xyloplacidae nov.

**Diagnoses:** The same as for class.

**Etymology:** *peri* and *podos* are Greek for 'around' and 'foot', referring to the nearly circumferential arrangement of tube feet.

*Xyloplax* n.gen.

**Type species:** *Xyloplax medusiformis* n.sp.

**Diagnosis:** Body medusiform, dorsally plated with peripheral, excavate spines and uniserial, nearly circumferential tube feet.

*Xyloplax medusiformis* n.sp. (see Figs 1-4)

**Etymology:** *Xylos* and *plax* are Greek for 'wood' and 'plate' and allude to the habitat and plating of this animal; *Medusa* and *form* are Latin and allude to the animal's superficial resemblance to a cnidarian medusa.

**Type material:** In the National Museum of New Zealand (NMNZ) and the Australian Museum (AM). The holotype (NMNZ 4240) was collected from 42°58.6' S, 168°21.9' E to 42°57.7' S, 168°22.6' E, west of Hokitika, South Island, at a depth of 1,142-1,147 m, on water logged wood, 9 July 1983. There are eight paratypes: four (one sectioned) (NMNZ 4239) collected from 41°09.9' S, 176°26.5' E off Castlepoint, North Island, at a depth of 1,174-1,208 m, on waterlogged wood, 4 April 1984; two (one sectioned) (NMNZ 4241) from 41°18.0' S, 176°18.3' E off Castlepoint, 1,170-1,152 m, 17 October 1984; one (NMNZ

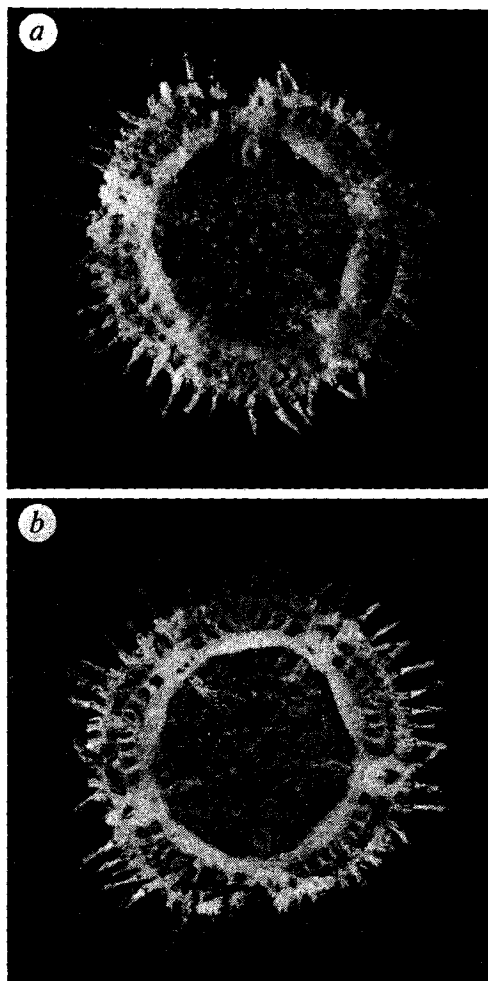


Fig. 1 Holotype (NMNZ 4240) of *Xyloplax medusiformis* n.g. and n.sp. Dorsal (a) and ventral (b) views. Diameter 3.1 mm.

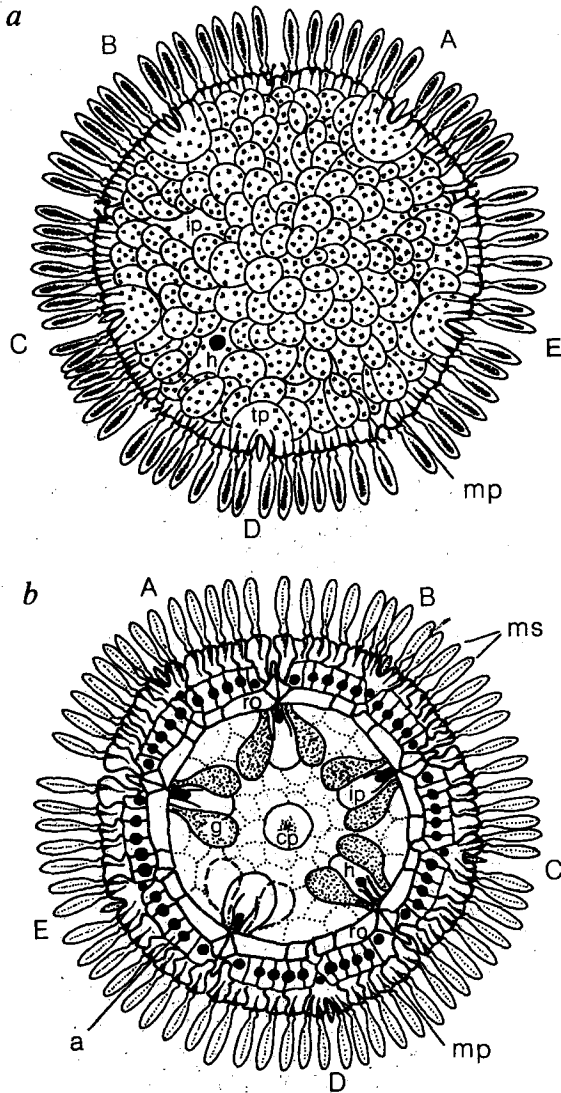
4242) from 41°25.3' S, 176°07.6' E off Castlepoint, 1,110-1,057 m, on waterlogged wood, 26 May 1985; one (AM J19660) from 41°24.7' S, 176°08.4' E off Castlepoint, 1,103-1,071 m, on waterlogged wood, 16 October 1984.

**Description:** The following description and figures are based on the type series, four of which had to be sectioned or dissected to obtain the required information. Our terminology must be regarded as provisional at this stage.

The specimens range from 2.1 (2.6) to 7.8 (9.0) mm in diameter (including peripheral spines). The animal is circular or slightly sub-pentagonal, and weakly inflated. The dorsal surface comprises numerous finely perforated, scale-like plates, which bear small, fluted spinelets. In each of the five inter-radii is a large primary plate, the one in inter-radius CD having a hydropore that pierces the plate. The margin of the disk is fringed by small (0.6 mm) excavate spines (Figs 1, 2), and is formed by a single ring of marginal plates interrupted by five large radial plates corresponding to the terminals or oculars of asteroids.

The ventral surface is dominated by a ring of thick skeletal ossicles, the adambulacral and marginal plates (Figs 1b, 2b). The 'intramarginal' ring comprises ossicles arranged in a pentamerous pattern. Each group of ossicles has four to six elements, the medial pair (each side of the inter-radial line) being the largest. Additional ossicles are developed at the radial positions during growth.

The water vascular system forms a double ring (Fig. 3). The inner water ring runs first in a groove and then in an enclosed duct along the inner side of the ring of ossicles. The 'radial'

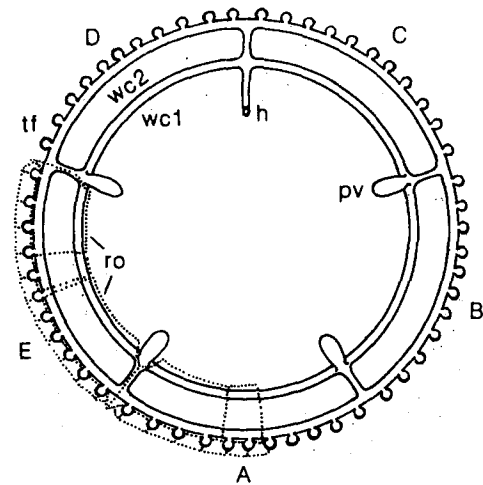


**Fig. 2** Semi-diagrammatic representation of paratype NMNZ 4241 of *Xyloplax medusiformis* n.g. and n.sp. Dorsal (a) and ventral (b) views. Diameter 6.2 mm. A-E, radii; ip, Primary inter-radial plate; mp, marginal plate; tp, terminal plate; h, hydropore; ms, marginal spines; g, gonad; ro, ring ossicle; a, adambulacral plates. cp, central dorsal plate.

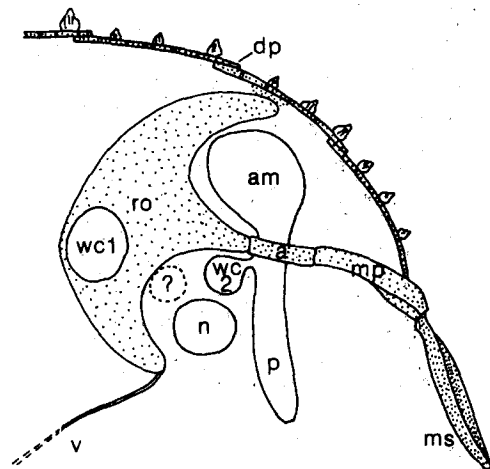
water canals (now outer circumferential) run along a lower, totally exposed groove on the outer side of the ring ossicles and connect with the inner ring at *inter-radial* positions. The 'radial' canal connects with each tube foot below the ampulla (Fig. 4). The tube feet are arranged in a uniserial, circumferential system, just inside the ventral margin of the disk (Figs 1b, 2b, 4).

There is no gut or mouth: the ventral surface of the animal comprises a complete and thin velum attached to the lower ridge of the ring ossicles below the groove carrying the 'radial' nerve and water canal (Fig. 4). There are five pairs of gonads or bursae which contain embryos at various stages of development, up to plated juveniles, which are similar in form to the adults.

The development of the inner water vascular ring and its protection in a groove/duct within the ossicles of the ring would not, in our view, be evolutionarily difficult to achieve. However, to meet the requirements of the new, circumferential arrangement of tube feet and the obliteration of any prolonged rays, medial splitting of the circum/radial structures, including the water canal (and presumably the nerve and haemal systems—not yet determined), must have occurred. This split could have originated as a lacuna at the junction of the circum-oral and



**Fig. 3** Diagrammatic representation of the water vascular system of *Xyloplax medusiformis* n.g. and n.sp., determined from histological sections and by dissection. pv, Polian vesicle; tf, tube foot; wc1, circum-oral water canal; wc2, 'radial' water canal. Other abbreviations as for Fig. 2.



**Fig. 4** Semi-diagrammatic section through the margin of *Xyloplax medusiformis* n.g. and n.sp., determined from histological sections and by dissection. am, Ampulla; dp, dorsal plates bearing fluted spinelets; n, 'radial' nerve; p, podium; v, velum; ?, 'radial' haemal canal. Other abbreviations as for Figs 2, 3.

radial canals. The lacuna could then have extended laterally and radially, stopping adjacent to the polian vesicles and terminal tube foot, respectively, and resulting in the water vascular system forming a double ring, with the connection between the two rings becoming inter-radial.

We suggest that the ossicle ring is derived from fusion of the first adambulacral/oral plate with the first two or three ambulacral plates. The tube feet must then have moved sideways and are now situated between the remaining adambulacral plates. The latter have been modified to take over the function previously fulfilled by the ambulacra. The whole inter-radial mouth frame (ossicle ring) has moved outwards, splitting the ambulacra and taking the associated circum/radial structures with it. The pivotal points are the terminal point of each radius; these points remain fixed so that a disk-like body form is derived.

We propose that the ventral velum of *Xyloplax* derived from the stretching of a simple, sac-like stomach from its original internal position, by opening of the oral frame. Thus, the outer surface of the velum is formed from the inner lining of the stomach.

Only two other classes of echinoderms have been described which have flattened, discoidal or medusiform bodies: Camptostromatoidea (Lower Cambrian) and Cyclocystoidea (Middle Ordovician–Middle Devonian). Recent studies have shown, however, that the camptostromatids do not have a medusiform body<sup>1</sup>. The cyclocystoids do have a body form that is superficially similar to that of *Xyloplax*; a comparative discussion will be published elsewhere.

We believe that *X. medusiformis* is likely to move from niche to niche using a parachute-like mode of locomotion in bottom-water currents.

We include the Class Concentricycloidea within the subphylum Asterozoa, rather than the Crinozoa or Echinozoa; this is justified on the grounds of pattern of growth, which occurs in typical asterozoan fashion<sup>2</sup>. Also, the tube feet occur between, not through, plates and on the underside of the animal. The diagnosis for the Asterozoa will need to be expanded to accommodate the special features of these new echinoderms, which we are also unable to classify within the only other asterozoan Class Stellerioidea<sup>2</sup>. Our discovery supports current views<sup>3–5</sup> that the present higher classification of the Echinodermata requires revision.

We thank the following colleagues for assistance: Mr Bruce Marshall, National Museum of New Zealand, sorted the echinoderms from sunken wood and discussed the habitat with us; Professor D. T. Anderson, University of Sydney, made valuable suggestions during the interpretation of this animal and arranged for Ms Kate Jakes to prepare histological sections; Dr Stephen Clark, Nelson Hospital, sectioned and photographed the tube feet; and Wim Spiekman, National Museum of New Zealand, made scale models of the ring ossicles. F.W.E.R. thanks the Marine Sciences and Technology Committee, Australia, for support. A.N.B. thanks the Zoology Department, Victoria University of Wellington, for the use of photomicrographic facilities.

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## Benzodiazepine impairs and $\beta$ -carboline enhances performance in learning and memory tasks

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Benzodiazepines are widely used anxiolytics and anticonvulsants, and their potent sedative properties are routinely used in pre-surgical anaesthesia. However, they are also known to induce a strong anterograde amnesia in patients<sup>1</sup>. Specific benzodiazepine antagonists have recently been described<sup>2,3</sup>, some of which have intrinsic pharmacological properties that are opposite to those of benzodiazepines. These have been called inverse agonists<sup>4,5</sup> and they have been shown to be proconvulsant or convulsant<sup>6,7</sup> whereas benzodiazepines are anticonvulsants. Inverse agonists are also anxiogenic<sup>8–12</sup> rather than anxiolytic. Since benzodiazepines induce anterograde amnesia, we have investigated the possibility that inverse agonists might also have an opposite effect for this property and so enhance acquisition (learning) and (or) retention (memory). We report here that, in three different animal models, an inverse agonist of the  $\beta$ -carboline group, methyl  $\beta$ -carboline-3-carboxylate ( $\beta$ -CCM), enhances animal performance in three different tasks used to investigate learning and memory.

The first model, habituation to a new environment in rodents, has been used previously to demonstrate the amnesic properties of benzodiazepines<sup>13</sup>. The second model, a passive avoidance task, has been widely used in the study of memory processes in rodents. Finally, to investigate the effects of  $\beta$ -CCM in a very different learning situation, a third model, imprinting in chicks, was used<sup>14</sup>. Imprinting, a phenomenon first described by Konrad Lorenz involves newly hatched birds which are apparently more 'naive' than adult rodents. The effects of  $\beta$ -CCM were compared with those of diazepam, a typical benzodiazepine.

In the habituation model, food-deprived mice were placed in an unfamiliar environment (a different cage) with food *ad*

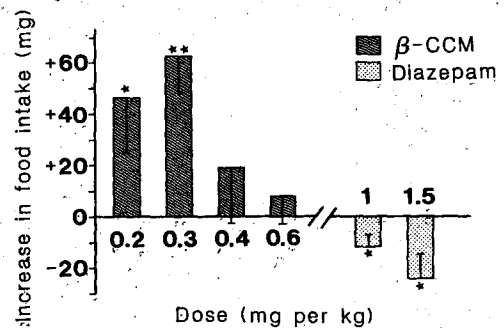


Fig. 1 Effect of  $\beta$ -CCM and diazepam on retention of habituation to a new environment in mice. The results show differences ( $\pm$ s.e.) in the food intake of drug-treated groups compared with saline groups. Hence, ordinate 0 corresponds to the mean of the food intake of saline-treated animals during the 2 min of the test ( $25 \pm 4$  mg,  $n = 60$ ). All groups consisted of 10 mice, except for diazepam, 1 mg per kg, where 20 mice were used. \*  $P < 0.05$ ; \*\*  $P < 0.01$  (analysis of variance).

**Methods.** Swiss mice (Iffa-Credo, France, males, 30 g) food-deprived for 24 h, were injected subcutaneously with  $\beta$ -CCM, diazepam or saline. They were transferred to the experimental room 15 min later and placed individually for 30 s in an unfamiliar metallic cage ( $32 \times 24 \times 15$  cm) containing their usual food. During this very short period, food intake was practically nil for all groups. No differences in locomotor activity could be measured among the groups; this was measured by dividing the floor of the cage into four identical squares and recording the number of times the animals crossed from one square to another during 30 s (number of crossings (mean  $\pm$  s.e.): controls  $2.8 \pm 0.4$ ;  $\beta$ -CCM, 0.2 mg per kg:  $2.3 \pm 0.4$ ;  $\beta$ -CCM, 0.3 mg per kg:  $3.6 \pm 0.5$ ; diazepam, 1.5 mg per kg:  $2.1 \pm 0.5$ ). Following this training session, mice were returned to their polystyrene home cage in the animal quarters with no food. Food was provided *ad libitum* at the end of the day. Three days later the mice were once more deprived of food. After fasting for 24 h, they were again placed in the metallic cage for a 2-min test session. Food intake was measured.

*libitum*. During this training session, they explored the new cage, but ate only a small quantity. When placed in the same environment for a test session a few days later, the same food-deprived animals ate much more than during the training session. This increase in food intake is assumed to indicate that during the