RESEARCH NOTE

First report of a case of occasional hermaphroditism in Polyplacophora

Agostina Scarano and Cristián Ituarte

División Zoología Invertebrados, Museo Argentino de Ciencias Naturales (C1405DJR), Buenos Aires, Argentina

Hermaphroditism has been defined as the production of eggs and sperm by the same individual (Heller, 1993). Among different types of hermaphroditism, one case is the simultaneous or functional hermaphroditism in which the production of eggs and sperm is concurrent. Functional hermaphrodites are found in nearly all phyla of invertebrates (Coe, 1943) and are occasionally found in gonochoristic species (Strathmann, Strathmann & Emson, 1984). These occasional cases of hermaphroditism may be considered as resulting from an alteration in the mechanism of sex determination. In occasional hermaphrodites, the proportion of male and female tissues can be variable, either having approximately the same quantity of each or one type may be represented by only a reduced number of cells (Coe, 1943).

Among molluscs, reports of occasional hermaphrodites are frequent in bivalves (Vinuesa, 1977; Ituarte, 1979; Darrigran, Damborenea & Penchaszadeh, 1998; Delgado & Pérez Camacho, 2002). Recently a case of pseudohermaphroditism, affecting the pallial portion of gonoducts but not the gonad tissues, probably determined by the environmental pollutant tributyltin, was reported in the cephalopod *Enteroctopus megalocyathus* from Patagonian coasts (Ortiz & Ré, 2006). Up to now, no cases of occasional hermaphroditism have been reported in polyplacophorans.

The vast majority of polyplacophorans are gonochoristic, the only exceptions are two simultaneous-hermaphroditic species from California: *Lepidochitona caverna* Eernisse, 1986 and *Lepidochitona fernaldi* Eernisse, 1986. These species are apparently capable of self fertilization, or at least fertilization is possible due to the coexistence of male and female gametes in the same gonad (Eernisse, 1988; Buckland-Nicks & Eernisse, 1993).

In this paper, a case of occasional simultaneous hermaphroditism found during a study on the reproductive biology of *Plaxiphora aurata* (Spalowsky, 1795) from the southwestern Atlantic Ocean is reported. One of 65 chitons sampled (1.5%) was hermaphrodite. The hermaphrodite specimen was collected on September 2007 on littoral hard substrata at Punta Cuevas (42°46′s 65°00′W), Chubut, Argentina.

The dissected gonad of the studied specimens was fixed either in Bouiń s fixative or Zenker's fluid with 10% formalin, then dehydrated in an ethanol series, and embedded in Paraplast®; sections of 5 μm thick were stained with haematoxylin and eosin.

The general structure of the gonad in the hermaphrodite specimen was similar to sexually normal specimens, a sacular gland with non-germinal tissue strands emerging from the ventral wall, onto which the germinal series develop. The gonad characteristics corresponded to a functional male, i.e. the male tissues were predominant; no signs of abnormality were observed in spermatogenesis or spermiogenesis. Several transverse sections showed a few scattered oocytes intermingled with male cells (Fig. 1A–C, E). The oocytes showed cytological characteristics similar to those found in normal oogenesis (Fig. 1F). Previtellogenic oocytes were characterized by a deep basophilic ooplasm with prominent vacuoles (Fig. 1A). Early vitellogenic and vitellogenic oocytes were encompassed by a reduced number of follicular cells (Fig. 1B–D). In transverse sections, vitellogenic oocytes showed a flower-like shape, as also reported in *Lepidochitona cinerea* (Richter, 1986); this peculiar shape is determined by deep incisions accompanied by follicle cells that appear in the ooplasm just before the onset of vitellogenesis and, in normal oogenesis, seems to play some role during the formation of the egg hull (Richter, 1986) (Fig. 1D). In some sections large amounts of mature sperms appeared in the gonad lumen, and strands of tissues corresponding to trabeculae of the female fraction were observed together with previtellogenic oocytes (Fig. 1E). Female cells seems not have had any chance of complete their development, as they were dislodged from the germinal epithelium and pushed to the lumen of the gonad by the maturational wave of male elements (Fig. 1A, E).

The authors express their gratitude to Pablo Penchaszadeh for allowing the use of the Zeiss Axioimager microscope used to illustrate this note. The study is part of a research project funded by PICT2005 38015 from the ANPCyT; A.S. and C.I. are members of CONICET.

REFERENCES

BUCKLANDS-NICK, J.A. & EERNISSE, D.J. 1993. Ultrastructure of mature sperm and eggs of the brooding hermaphroditic chiton, *Lepidochitona fernaldi* Eernisse, 1986, with observations on the mechanism of fertilization. *Journal of Experimental Zoology*, **265**: 567–574.

COE, W.R. 1943. Sexual differentiation in mollusks. I. Pelecypods. *Quarterly Review of Biology*, **18**: 154–164.

DARRIGRAN, G.A., DAMBORENEA, M.C. & PENCHASZADEH, P.E. 1998. A case of hermaphroditism in the freshwater invading bivalve *Limnoperna fortunei* (Dunker, 1857) (Mytilidae) from Río de la Plata, Argentina. *Iberus*, **16**: 99–104.

DELGADO, M. & PÉREZ CAMACHO, A. 2002. Hermaphroditism in *Ruditapes decussatus* (L.) (Bivalvia) from the Galician coast (Spain). *Scientia Marina*, **66**: 183–185.

EERNISSE, D.J. 1988. Reproductive patterns in six species of *Lepidochitona* (Mollusca: Polyplacophora) from the Pacific Coast of North America. *Biological Bulletin*, **174**: 287–302.

HELLER, J. 1993. Hermaphroditism in molluscs. *Biological Journal of the Linnean Society*, **48**: 19–42.

ITUARTE, C.F. 1979. Sobre la sexualidad de *Glycymeris longior* Sow. *Neotropica*, **25**: 161–165.

ORTIZ, N. & RÉ, M.E. 2006. First report of pseudohermaphroditism in cephalopods. *Journal of Molluscan Studies*, **72**: 321–323.

RICHTER, H.P. 1986. Ultrastructure of follicular epithelia in the ovary of *Lepidochitona cinerea* (L.) (Mollusca: Polyplacophora). *Development, Growth and Differentiation*, **28**: 7–16.

STRATHMANN, R.R., STRATHMANN, M.F. & EMSON, R.H. 1984. Does limited brood capacity link adult size, brooding, and simultaneous hermaphroditism? A test with the starfish *Asterina phylactica*. *American Naturalist*, **123**: 796–818.

VINUESA, J.H. 1977. Sobre un caso de hermafroditismo en la cholga *Aulacomya ater* (Molina). *Physis*, **37**: 63–65.

Correspondence: A. Scarano; e-mail: scarano@macn.gov.ar

doi:10.1093/mollus/eym039
Advance Access Publication: 24 December 2008

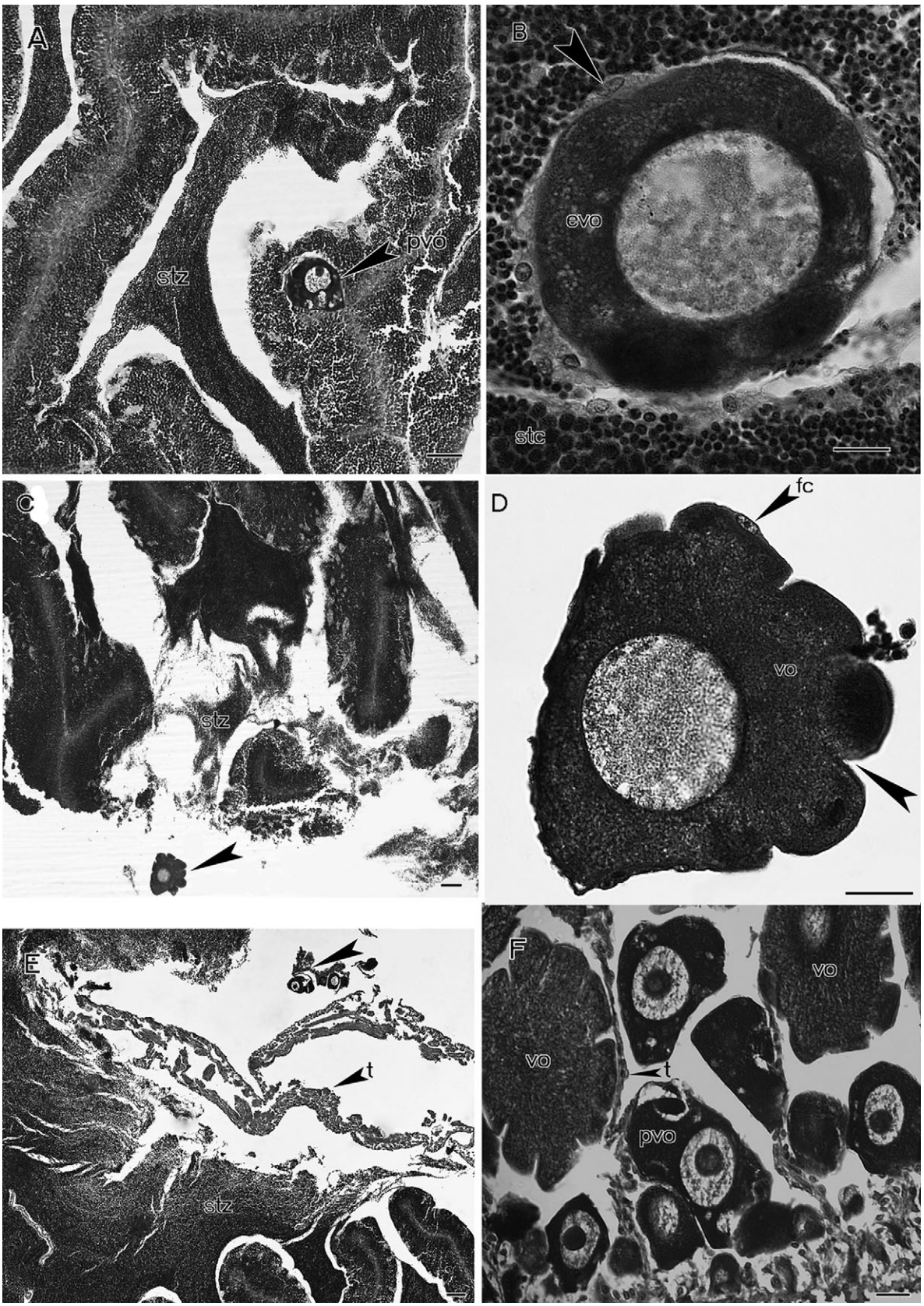

Figure 1. *Plaxiphora aurata*. **A**–**E.** Hermaphrodite specimen. **A.** General aspect of the gonad showing a previtellogenic oocyte with large vacuoles in the cytoplasm. **B.** Detail of an early vitellogenic oocyte encompassed by follicle cells (arrow). **C.** General aspect of the gonad showing a vitellogenic oocyte. **D.** Detail of **C**, showing a vitellogenic oocyte with the characteristic ooplasm incisions (arrow). **E.** General aspect of the gonad showing three previtellogenic oocytes (arrow) and fragments of trabeculae detached from gonad wall. **F.** Transverse section of a female gonad and normal oogenesis. Abbreviations: evo, early vitellogenic oocyte; fc, follicle cell; pvo, previtellogenic oocyte; stc, spermatocytes; stz, spermatozoids; t, trabecula; vo, vitellogenic oocyte. Scale bars **A** = 50 μm; **B** = 20 μm; **C** = 50 μm; **D** = 20 μm; **E** = 50 μm; **F** = 20 μm.