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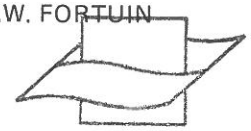
THE ANNUAL CYCLE OF GLYCOGEN IN ESTUARINE BENTHIC ANIMALS

H. HUMMEL, L. DE WOLF and A.W. FORTUIN

(Shortened paper)



Glycogen is an important reserve constituent in invertebrate animals, especially in bivalves (BAYNE and NEWELL, 1983; GABBOTT, 1983; GADE, 1983; AKBERALI and TRUEMAN, 1985). It may be used to overcome long periods of food shortage, as in winter, or to mitigate shortterm periods of stress like periods of anoxia or prolonged emersion. Moreover glycogen can be reallocated during gametogenesis from the soma into (glycogen and lipid) reserves in follicles and gametes. Consequently, minimal values in the glycogen content may be expected at the end of a winter or reproduction period. Most information on annual cycles of glycogen in marine benthic animals is available for commercially important species, *e.g. Mytilus edulis* (ZANDEE *et al.*, 1980; DE ZWAAN and ZANDEE, 1972a), *Ostrea edulis* (RUSSELL, 1923; GAARDER and ALVSAKER, 1941; KRVARIC, 1953; WALNE, 1970) and *Arenicola marina* (DE VOOYS, 1975). From studies on the effects of prolonged emersion on estuarine benthic animals (HUMMEL *et al.*, 1986a, b) additional information is available on the annual cycle of glycogen in some non-commercial animals. In the present study new data on annual changes in glycogen content of both commercial and non-commercial benthic species are presented. The changes are related to season and reproduction period.

Animals were sampled in the Southwest Netherlands, from intertidal areas in the Oosterschelde, mostly near Yerseke, with the exception of *Ostrea edulis* which was sampled subtidally in the brackish Lake Grevelingen. After sampling the animals were stored at – 20 °C before analysis. For the glycogen analysis 5 to 10 animals were pooled. The measurements were performed according to the method of VAN HANDEL (1965), modified by DE ZWAAN and ZANDEE (1972b). Glycogen content was expressed as a percentage of the dry flesh weight obtained after drying at 80 °C for 3 days.

Spawning periods, which indicate the end of the reproduction period, were taken from the literature : for *Mytilus edulis* L. from BAYNE (1976) and SASTRY (1979), for *Cerastoderma edule* (L.) from CREEK (1960), BOYDEN (1971), KINGSTON (1974), SEED and BROWN (1977) and NEWELL and BAYNE (1980), for *Ostrea edulis* L. from KORRINGA (1941) and WILSON and SIMONS (1985), for *Littorina littorea* (L.) from ANKEL (1936), FRETTER and GRAHAM (1962) and WOLFF (1973), for *Arenicola marina* (L.) from WOLFF (1973), DE VOOYS (1975), DE WILDE and BERGHUIS (1970) and MAYES and HOWIE (1985), for *Nepthys hombergii* Savigny from WOLFF (1973) and OLIVE *et al.* (1985), and for *Sagartia troglodytes* (Price) from PAX (1936), RIEMANN-ZURNECK (1969) and CAMPBELL (1974). For *Diadumene cincta* Stephenson no data are available.

Most species showed considerable seasonal changes in the glycogen content; high values were found in summer and autumn, low values in winter and spring (Fig. 1). The glycogen content in the bivalves reached the highest values, up to 30 % of the dry weight, and showed the strongest fluctuations. The glycogen content of all other species remained below 10 %. Similar values and fluctuations were found before for *Mytilus edulis* (ZWAAN and

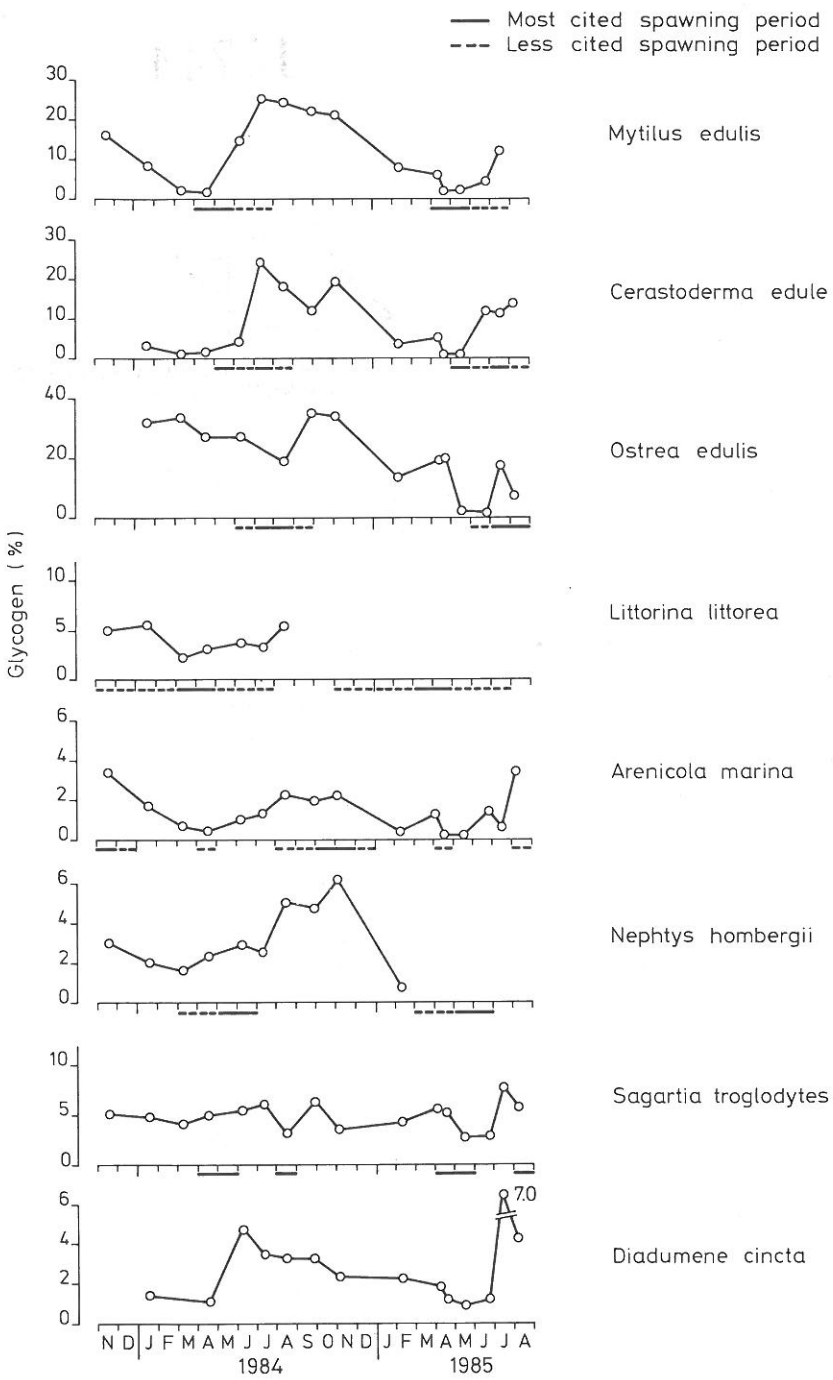


Fig. 1. Seasonal cycle of the glycogen content (in percentage of the dry flesh weight) in estuarine benthic animals. At the abscissa the spawning period is indicated (the most cited spawning period is that period which is mentioned by more than 50 % of the reviewed authors).

ZANDEE, 1972a; ZANDEE *et al.*, 1980) and *Arenicola marina* (DE VOOYS, 1975). For *Ostrea edulis* also similar high values were reported, however, changes were hardly present throughout the year or a slight minimum appeared already in late winter or early spring (RUSSELL, 1923; GAARDER and ALVSAKER, 1941; KRVARIC, 1953; WALNE, 1970).

Nutritional stress may be one of the causes for the decrease of the glycogen content during winter. Food conditions in the Oosterschelde improve during spring (BAKKER and VAN RIJSWIJK, 1987; VEGTER and DE VISSCHER, 1987), and thus an increase in glycogen content might be expected from that time on, as can be seen in *e.g. Mytilus edulis*. As mentioned before a decrease in the glycogen content might be caused by gametogenesis too. However, for some species spawning takes place (partly) during the end of winter or spring (Fig. 1). Thus, the development of gametes must have taken place during winter too, and therefore, it is not possible to distinguish during winter between the contribution of nutritional stress and gametogenesis to the decrease in glycogen. Yet, indications that gametogenesis and spawning play an important role in decreasing the glycogen content can be found in spring and summer, namely : 1) after the minimum for glycogen in winter another minimum is found in or near the spawning period in summer or autumn (*Cerastoderma edule* in 1984, *Ostrea edulis* in 1985, *Arenicola marina* in 1985, *Sagartia troglodytes*); 2) after winter an ongoing decrease is found during the spawning period (*Ostrea edulis* in 1984); and 3) after winter a drop in the glycogen content is found in or near the spawning period (*Cerastoderma edule* in 1985, *Nepthys hombergii, Littorina littorea*).

From this it is concluded that major changes in the glycogen content of estuarine invertebrates can be coupled to food conditions as well as to reproduction. This holds for bivalves, a gastropod, polychaetes and an anemone.

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Address of the authors :
Delta Institute for Hydrobiological Research, Vierstraat 28, 4401 EA Yerseke, The Netherlands.

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