DO INSECTS HAVE TACHYKININS?

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ABSTRACT

Several peptides have been found in insects that cause a rapid acceleration in the movement of the visceral muscle. Such activity is remarkably similar to the vertebrate tachykinin peptides.

In the etymological sense, any substance that causes the rapid acceleration of movement in muscle tissue could be called a tachykinin. However, the term usually refers to certain vertebrate peptides that activate organs of the viscera. For example, it has been recognized for more than 50 years that substance P (Arg-Pro-Lys-Pro-Gln-Gln-Phe-Phe-Gly-Leu-Met-NH_2) stimulates contractile activity in a variety of smooth muscle preparations. Erspamer (1981) remarked that only one tachykinin has been isolated and chemically identified from invertebrates, the octopod peptide eledoisin. However, recent reports that the insect peptide proctolin causes a decrease in blood pressure (O'Shea 1982) and accelerates movement in the ileum of the rat (Schultz et al. 1981) offer strong evidence that proctolin is also a tachykinin.

In fact, we have isolated another tachykinin-like peptide from head extracts of the cockroach Leucophaea maderae (Holman and Cook 1979). This peptide, the hindgut stimulating neurohormone (HSN), is indistinguishable from proctolin on several high-performance liquid chromatographic (HPLC) systems.

When Brown and Starratt (Brown 1975; Brown and Starratt 1975; Starrat and Brown 1975) isolated and identified proctolin (Arg-Tyr-Leu-Pro-Thr) from whole body homogenates of Periplaneta americana, they suggested that proctolin and the HSN that we had previously described (Holman and Cook 1972) were identical. This observation seemed reasonable on the basis of molecular weight, basicity and biological activity. However, after a careful comparison of our findings with those of Brown and Starratt, several anomalies could not be resolved. Brown (1967) stated that the gut factor (proctolin) differed from the other factors he had isolated from the corpus cardiacum (cc) (Brown 1965) in several ways: 1) The factors from the cc were inactivated by chymotrypsin but proctolin was not; and 2) The action of proctolin on the hindgut was distinct from the effects of the substances found in the cc. In addition to these distinctions, we demonstrated the synthesis, transport, and release of HSN in cultured brains and neuroendocrine organs (Marks et al. 1973; Holman and Marks 1974; Marks and Holman 1974). Thus if proctolin and HSN are identical, as proposed, then proctolin must be synthesized in the brain, then transported to and released by corpus cardiacum. However, several experimental approaches have now confirmed that only trace amounts of proctolin exist in the brain of the cockroach. Both radioimmunoassay (Bishop et al. 1981) and immunocytochemistry (Eckert et al. 1981) have shown only widely scattered proctolin-containing cells in the brain of Periplaneta americana. Moreover, the extraction and quantitative determination of proctolin by derivitization and HPLC from head extracts of Leucophaea maderae indicate that the peptide is either absent or below detectable levels (Holman and Cook 1979). Finally, the trace amounts of proctolin found by RIA can in no way account for the biological activity we found in head extracts. We conclude that a second compound, similar to but not identical to proctolin is

responsible for the tachykinin-like activity in head extracts; the evidence is based upon the absence of proctolin. A recent immunofluorescence-histochemistry study of the cockroach nervous system (P. americana) (Eckert et al. 1981) also suggests that one or more peptides with a chemical resemblance to proctolin are present in the nervous system. O'Shea and Adams (1981) have recently demonstrated that the lateral neurons of the cockroach (P. americana) abdominal ganglia contain proctolin and a very similar second material with proctolin-like bioactivity. The two compounds were not separated by reverse phase chromatography on a C-18 column with acetonitrile-water, nor could they be separated in three butanol based thin-layer chromatography systems. However, proctolin and the proctolin-like compound were completely resolved when chromatographed on cellulose thin-layer plates with methylethylketone-acetic acid-water (15:5:3).

Although the precise function of the peptide HSN found in head extracts of the cockroach Leucophae maderae remains uncertain, it is quite evident that it causes a tachykinin-like response in visceral muscle as does proctolin. Thus it is not unresonable to refer to these peptides as tachykinins. Only further research, however, can determine whether these tachykinins in insects function as neurohormones, as neurotransmitters, or both. Generally in the past peptides have not been considered neurotransmitters, but there is now good evidence for some 20 such peptides in the central nervous system of vertebrates, and the number could exceed 200 if all were known (Snyder 1980).

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