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THE INVESTIGATION OF THE SPONTANEOUS ACTIVITY AND EVOKED POTENTIALS AT CELLULAR LEVEL IN THE CENTRAL NERVOUS SYSTEM OF FRESH-WATER MUSSEL (*ANODONTA CYGNEA* L.)

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Considering the activity pattern, chemical sensitivity and other physiological properties there are different cell types in the central nervous system (CNS) of invertebrate animals (TAUC, 1967), the functions of which are likewise different and presumably, they regulate different physiological processes. However, on the other hand, the cell activity is influenced by the peripheral processes in various ways, according to types and cases, that may play an integrative or reflex role.

Most of the investigations of such type have been performed on Gastropods among the Molluscs (WILLOWS and HOYLE, 1968; PERETZ, 1969; KUPFERMANN et al., 1971; WEEVERS, 1971; S.-RÓZSA and SALÁNKI, 1973).

In the course of the investigations carried out on Pelecypods, the ganglionic transmission was examined formerly in intact animals and in isolated preparations, too (HORRIDGE, 1961; SALÁNKI and VARANKA, 1969; VARANKA, 1972). Though, some information regarding the general nature of the pathways passing through the ganglion were obtained as the result of these investigations but the interpretation of the results was complicated owing to the presence of the great number of neurones involved.

Among the Pelecypods, investigations at cellular level have only been carried out on *Spisula solida*. In this case, different cell types were shown in the visceroparietal ganglion, the physiological properties and functions of which are connected with the pecularities of their localization within the ganglion (MELLON, 1965; 1967; 1972; MELLON and MPITSOS, 1967; MELLON and PRIOR, 1970; PRIOR, 1972 a, b).

In the present experimental series, investigations at cellular level have been performed on *Anodonta cygnea*, in order to determine the spontaneous activity of the neurones and the electrophysiological properties of the evoked potentials of the individual neurones subsequent to nerve stimulation.

Methods

Large, 18—20 cm long specimens of fresh-water mussel, *Anodonta cygnea* L. were used in the experiments. Both adductors were cut and then, one of the shells was removed. The visceral ganglion (VG) was opened up, the

connective tissue sheath covering VG was removed, and the nerves running out from the ganglion were exposed. The right sypho nerve (nervus pallialis posterior maior, nppm) at a distance of about 10—15 mm, the other nerves at 3—5 mm from the VG were transected. Following this, VG was removed together with a piece of the posterior adductor muscle from the animal and fixed by virtue of the muscle piece in an experimental chamber, downward with its ventral side.

For the stimulation of the nppm suction-electrodes were used. A platinum wire connected the suction-electrode to one of the poles of an ALVAR PHYSIOVAR stimulating apparatus through an isolating-unit of reversal, of constant current and of radiofrequency. The other pole of the stimulating apparatus was earthed, then switched to a spiral platinum wire placed around the suction-electrode. In such a way, the stimulating-circuit is closed through the peak of the suction-electrode and both anodic (+) and cathodic (—) asymmetric square pulses may be applied upon the nerve section included in the electrode.

The experimental arrangement is shown in the *Fig. 1.* For the extracellular recording of the evoked potentials 7—20 MOhm glass microelectrodes filled with 2.5 M KCl, sometimes with potassium-citrate were used. The microelectrode was connected to a negative capacitance compensation FET cathode follower with high input resistance (KISS et al., 1972). In the circuit of the indifferent electrode there was an agar-bridge, and an Ag-AgCl electrode was switched to it as well as to the microelectrode.

The voltage changes registered by the microelectrode were driven from the FET cathode follower to a DISA 51 B 01 amplifier and then, recorded on a TEAC R—200 FM date recorder and there from it was photographed. In order to make the signs visible DISA UNIVERSAL INDICATOR was used.

The depth and place of the peak of the electrode were noted in the cases of all neurones giving valuable answer.

During the experiments the preparations were kept in MARCZYNSKY's (1959) physiological saline.

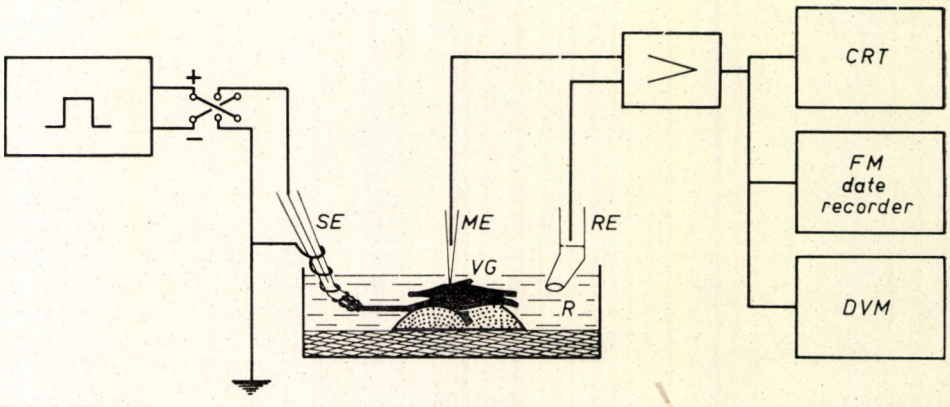

Fig. 1. Experimental arrangement. SE — suction electrode, VG — visceral ganglion, ME — microelectrode, RE — reference electrode of agar-bridge, R — Ringer-solution, CRT — cathode ray tube, DVM — digital voltmeter

Results

During data processing the data obtained from 71 different neurones of 32 preparations were considered. Under experimental conditions the neurones of VG were silent or possessed a spontaneous activity.

Because of th intracellular registration of the activity of the neurones the amplitude of the spontaneous and evoked potentials were between 600 and 2500 μV, and their duration 2—20 msec at the half-amplitude. Apart from some rare cases, the recorded activity originated from one cell, and for its determination the form, sequence and amplitude of the neurones were taken into consideration.

1. *The spontaneous activity of the neurones*

From the investigated 71 neurones 54 were silent, while 17 had spontaneous activity. The average frequency of the neurones showing spontaneous activity was 0.78 cps with extreme values of 0.03 and 2.3 cps.

The neurones exhibiting spontaneous activity can be grouped according to the activity pattern as follows: irregular (of unequal distribution, *Figs 9A* and *10*), or regular activity (pacemaker-type, *Figs 8* and *9B*). A special case of this latter type is the grouped, burst appearence of the potentials (similar to the bimodal pacemaker-type, *Fig. 11*) and the burst-intervals are repeated with a relative regularity, giving an average value of 20—25 sec.

2. *Neuronal responses given on single shock and stimulus train*

After a single shock and stimulus train of different frequency applying to the right nppm a primary and a secondary response of the neurones can be distinguished. The primary response occurred both at silent and at spontaneously active neurones, indicating really one or more action potentials evoked by the simulation from the neurone. Secondary responses could only be observed in spontaneously active neurones and they indicate the alteration ensued in the spontaneous activity (inhibition, stimulation and change in the burst-activity) after the primary response.

a) *Primary responses*

In the investigations suprathreshold anodic and cathodic stimulation with an impulse-width of 1 msec were applied as single impulses and serial ones of 0.1—10 cps, respectively. On the basis of conduction speed, "frequency-following" and other characteristics two response-types could be distinguished among the primary responses recorded from the neurones on the effect of stimulation.

1st response-type: these responses may consist of one or more spikes following a single square-pulse. In this latter case the number of spikes was generally 3—6 but in an extreme case 25, too *(Figs 2A* and*5)* and they might be burst-like. Applying stimuli of identical intensity as single shocks, the number of the response impulses may be varying as well as their duration

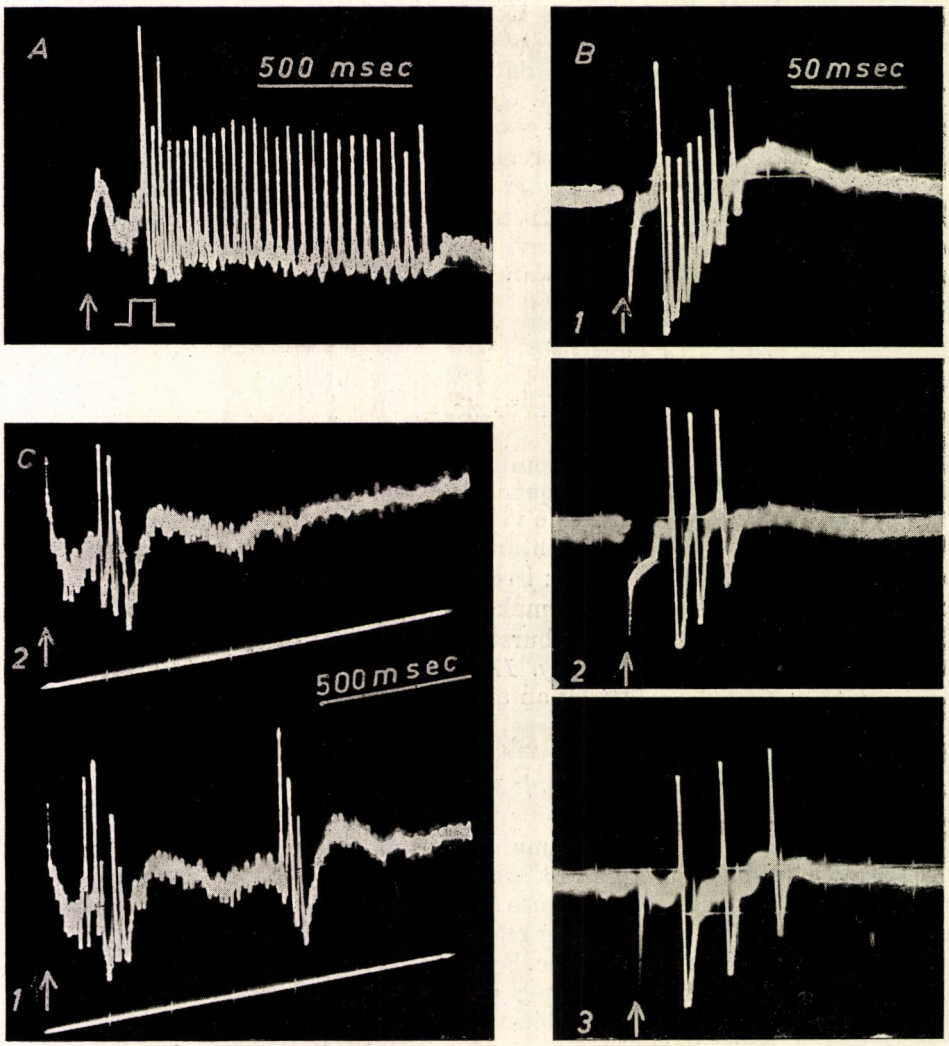

Fig. 2. Primary responses of 1st type. A — burst-response to a single shock, B — response of labile latency to a stimulus train of 0.1 cps, and C — double burst response evoked by a single shock, following the second stimulus there is only one burst (the time interval between the two stimuli is 10 sec, the numbers indicate the stimuli following each other)

(Fig. 2B). Sometimes, one neurone reacted to a single shock with two impulse-trains *(Fig. 2C)*.

Increasing the intensity of the stimulus, it has been found in the case of the neurones responding with bursts that after a weak suprathreshold stimulus the number of the spikes of the burst is of the highest, while at supramaximal stimulus-intensity the number of spikes and the duration of the response generally decrease *(Fig. 3A, B)*, but an increase also occurs *(Fig. 3C)*.

Comparing the effect of anodic and cathodic stimulation, it was found that 63% of the neurones reacted to the stimuli of both polarities after square

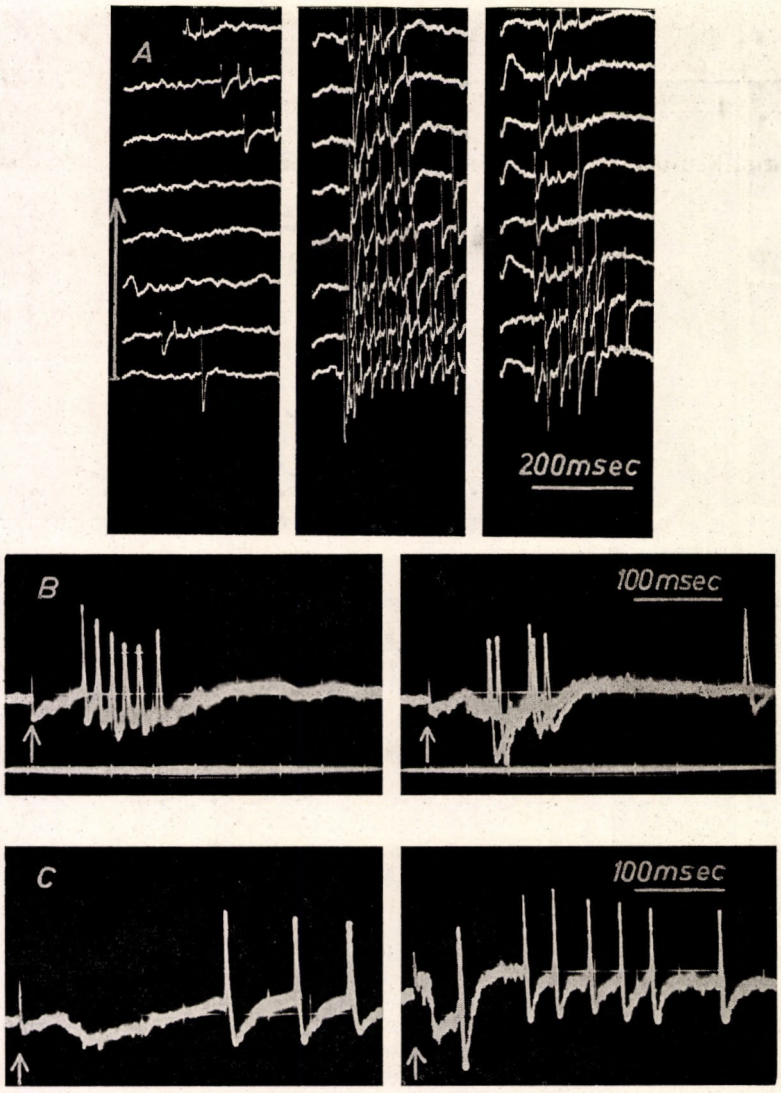

Fig. 3. Effect of the alteration of stimulus-intensity on the burst-response in the case of three neurones. A — recording-series represent increasing intensity at 0.1 cps stimulus-frequency. At the third supramaximal stimulus the response seems to be smaller, and its decrease within the series greater than at a weak suprathreshold stimulus-intensity. B — decreasing response given to an increasing intensity, and C — stronger response given to increasing intensity where the latency decreases, too. Vertical arrow: the sequence of the stimulus-impulses

wave impulses with the same intensity. Following on anodic stimulus 92% and a cathodic 71% gave a response, consequently, the anodic stimulus is more effective. It may also be seen in cases when the neurone responds to stimuli of both polarities, the response to the anodic stimulus is larger than to the cathodic stimulus *(Figs 4A* and *7A)*.

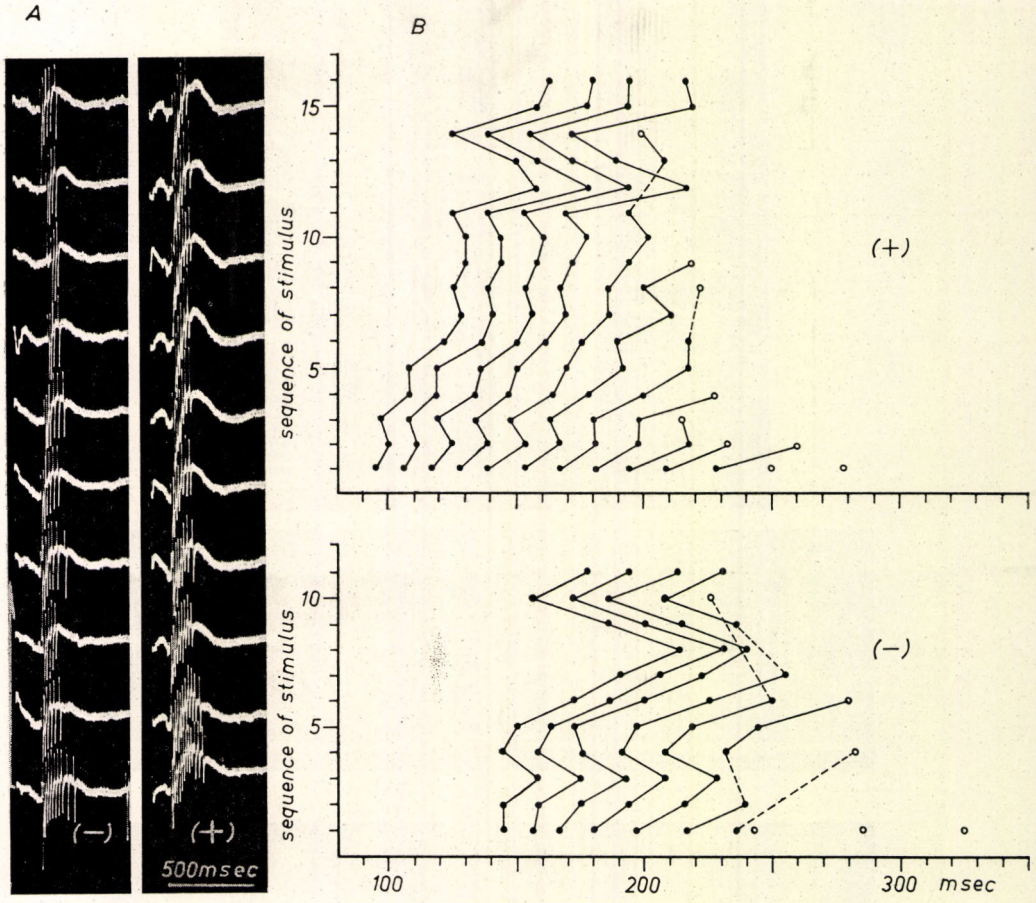

Fig. 4. A — responses of the same intensity, evoked by 0.1 cps cathodic and anodic stimulus trains, B — latency alteration of the potentials of the former responses on the effect of stimuli following each other (circles: the latency of those last potentials of the responses which are not already evoked by the following stimulus; continuous line; the potentials of identical serial number of neighbouring responses; broken line: the potentials of identical serial number of non-neighbouring responses. (+) anodic and (−) cathodic stimulation)

The latency of the responses shows also a pecularity depending on the polarity of the stimulus, since the latency of the anodic responses are generally smaller than that of the cathodic ones *(Figs 4* and *7)*. Calculating on the basis of latency-time and the distance between the stimulating and recording electrodes, the velocity of the conductance was 15.5 cm/sec. It was 5—20 cm/sec at 87% of the neurones and the fastest was only 33.5 cm/sec, too.

Investigating the latency of the responses after a stimulus train of given frequency, it might be established that in the overwhelming majority of the neurones the latency of the responses following each other is increased *(Fig. 4)*. It was about average at trains of 0.1 cps frequency but sometimes, very inten-

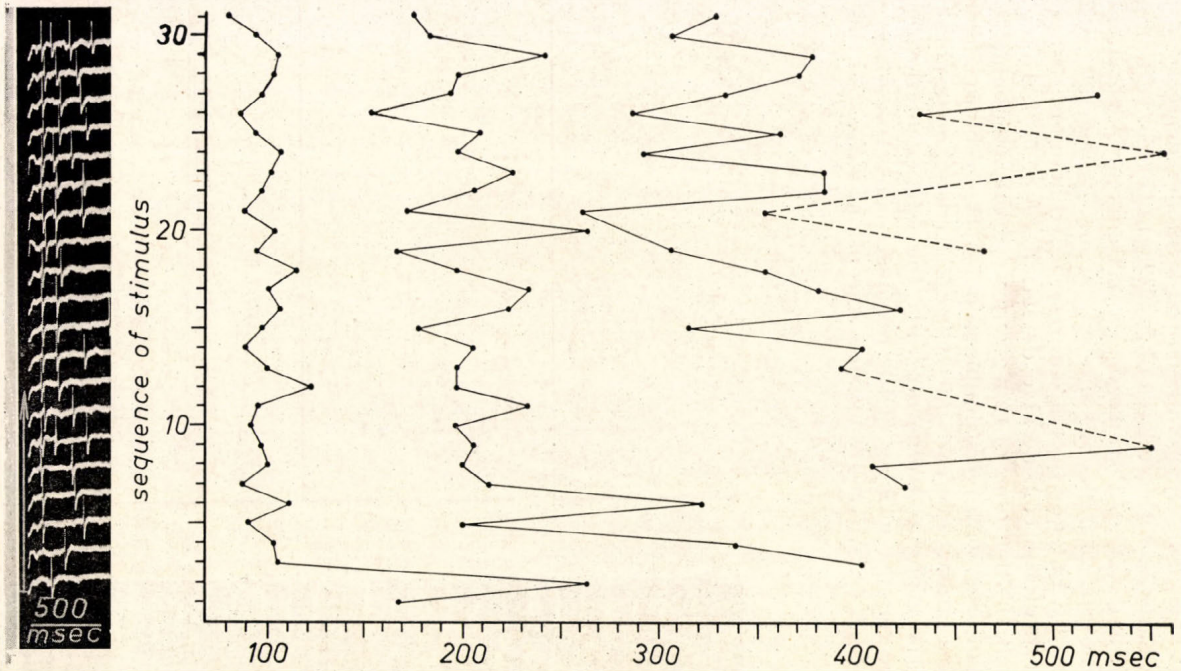

Fig. 5. The latency-alteration of the potentials of responses given to a stimulus train of 0.5 cps frequency. Note the latency-decrease of the first potential and the increasing response

sive; exception was never found. At the 10th impulse of the stimulus train the latency-increase was 7—85%, with an average of 30%. At a train of 0.5 cps this value shows a 16% average latency-increase, with extreme values of 9% and 38%. However, some neurones showed a latency-decrease in the case of 0.5 cps trains, namely, with a degree of 8—12% untill the 10th impulse of the train *(Figs 5.* and *6B)*. At trains of 1 cps frequency, the latency-increase measured at the 10th stimulus-impulse was at an average 15%, with extreme values of 10—20%. Latency-decrease also occurred here but its averaging was difficult because of the considerable deviation *(Fig. 6C)*. Here, we should like to note that the neurones of this group were already unable to follow the stimulus train of 5cps, within 5 stimulus-impulses the response already stopped (there was also a latency-decrease until the cessation of the response).

Within the stimulus trains not only the latency of the response was altered but the impulse-number of the responses consisting of several spikes, too *(Figs 3A* and *4)*. Apart from a few exceptions *(Fig. 5)*, this alteration

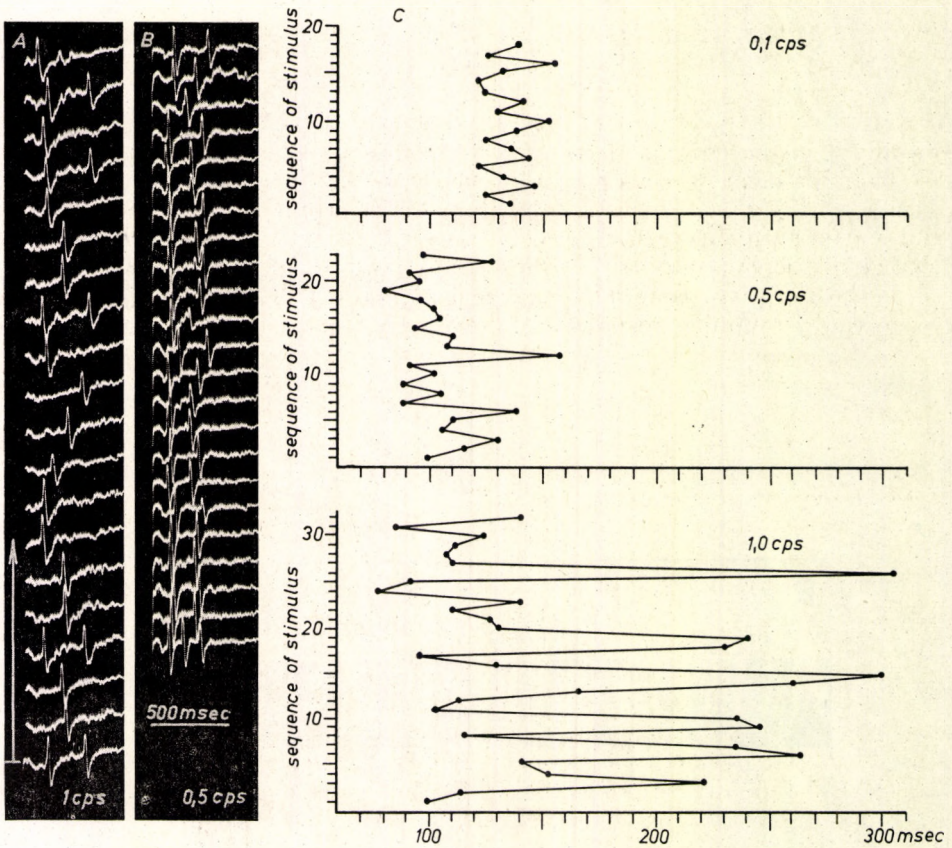

Fig. 6. A and B — responses given to 0.5 and 1.0 cps stimulus trains, C — latency-alteration of the first potential of responses given to 0.1, 0.5 and 1 cps stimulus train, showing an increasing tendency at 0.1 cps and a decreasing one at 0.5 cps

manifested itself in the decrease of the number of impulses at all stimulus-frequency. It is interesting that how considerable was the decrease of the spike-number of the individual responses within the stimulus train in the case of a stimulus train of such a low frequency as 0.1 cps. At the 10th impulse of the stimulus this value showed 20—80% decrease. We failed to find any significant difference in the decrease of the number of discharges of the responses according to the polarity of the stimulus train applied.

As it is seen above, the magnitude of the response is generally decreased within the stimulus train of a given frequency. At the same time, however, by increasing the intensity of the stimulus during the stimulus train, the decreased response is temporarily increased, then decreased again. In this case, the increase of the response is accompanied by some decrease of the latency, too.

In connection with the responses given to the stimulus trains we should like to note here that in the course of our investigations we failed to find any such neurone which would give more than 70—80 responses to the applied stimulus train of the lowest frequency of 0.1 cps *(Fig. 7D)*. This value was further diminished by the increase of the frequency of the stimulus train.

At the stimulus trains the excitement duration of the response (the time between the first and last spike) was also decreased along with an increase in latency and with a diminution in the number of discharges of the response *(Figs 3* and *4)*.

In cases when the neurone reacted only with one potential upon the stimulus, the latency-increase and frequency-following of the spike within the stimulus train were also similar to those of the former neurones responding with several spikes. The responses of such a neurone is shown in *Fig. 7A*, *B* and *C* after stimulus trains of 0.1, 0.5 and 1.0 cps, while in *Fig. 7D* the latency change of the response can be seen in the case of a stimulus train of 0.5 cps.

The activity pattern of the neurone shown in *Fig. 7E* is interesting because of its double response. Following an anodic stimulus it reacts first with a fast potential of short latency and then, follows a slow response of longer latency, consisting of several spikes. On the cathodic (generally less effective) stimulus the slower response consisting of several spikes remained only and its latency was also greater.

2nd response type: five cases out of 71 neurones responses differ from these described above. At these neurones, the average of the conductance velocity calculated from the distance of the stimulating and recording electrodes and from the duration of the latency was 53.6 cm/sec, with extreme values of 37.5 cm/sec and 69.8 cm/sec. Places for recording included here too, the anterior and posterior parts of VG as well as regions localized ipsi- and contralaterally to the stimulated nppm.

The latency-increase following the stimulus trains could also be observed in the case of these neurones but was considerably smaller (e. g. at the 10th impulse of a stimulus train of 1 cps the latency-increase was 4—6%). They differ from the former type in that that their frequency following is higher. They react to the first impulses of the stimulus train of a 10 cps frequency, too.

It is interesting that five neurones referred to responded to anodic stimulus, though it may well be by mere chance.

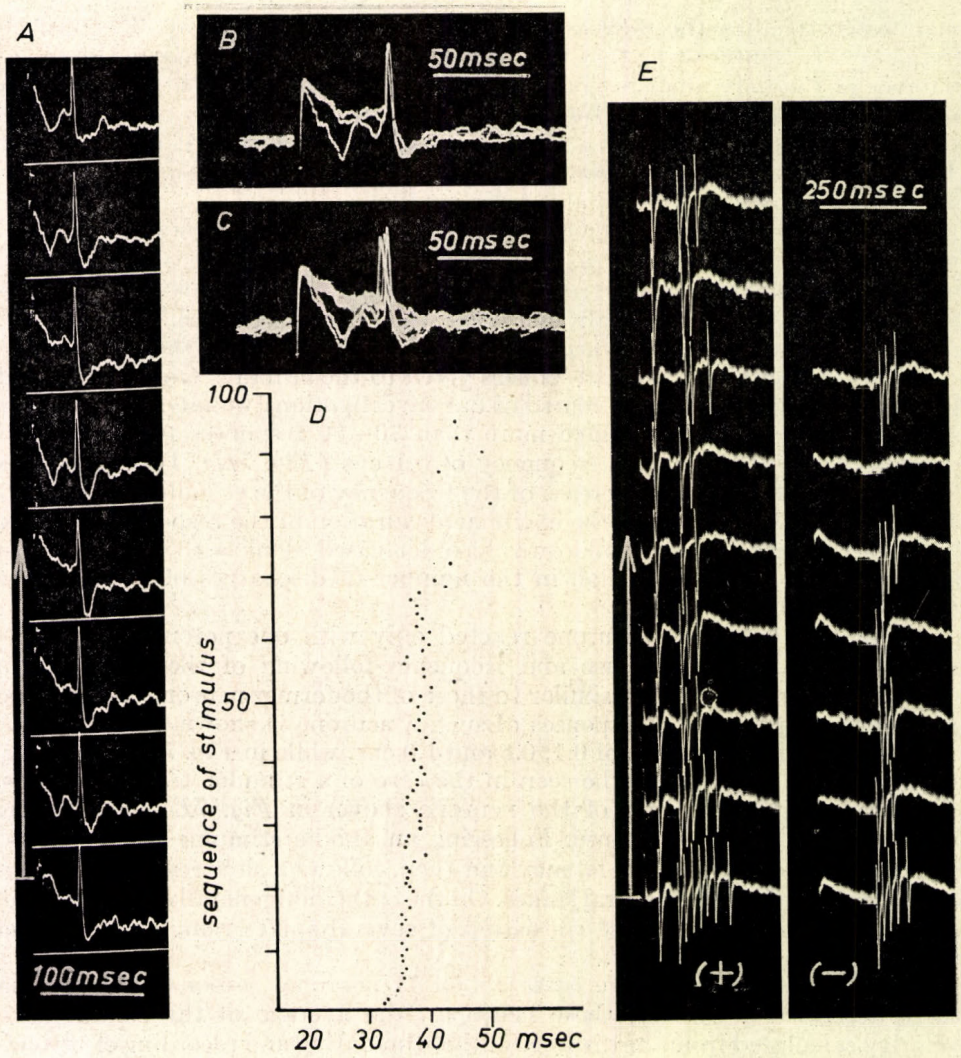

Fig. 7. A, B and C — responses given to 0.1, 0.5 and 1 cps stimulus trains in the case of neurones responding with a single potential (B and C superponated recordings). D — latency-alteration of the same neurone at a 0.5 cps stimulus train. E — responses of another neurone after anodic and cathodic stimulus trains of 0.1 cps. It is notable that the latency of the cathodic responses are longer and the separated, fastest component is absent

b) *Secondary responses*

In addition to the primary responses described above, the secondary effect of the single shock and of the stimulus train was also observed in the non-bursting neurones possessing regular or irregular spontaneous activity and displaying a stimulus frequency dependence, too.

Short-time inhibition

In this case the single shock and stimulus train show the same effect. Following the stimulus impulses the spontaneous activity of the neuron is inhibited for 2—10 sec *(Fig. 8)*. The last, finishing spike of the stimulus train has also this effect. The short-time inhibition occurred in the case of single stimulus-impulses as well as of stimulus trains of 0.1—1.0 cps frequency. If the inter-stimuli intervals were exceded by the duration of inhibition, the spontaneous activity ceased during the whole period of the stimulus train, and only the primary responses evoked by the single stimulus-impulses were seen. It so happened that the spontaneous activity of the neurone was temporarily enhanced after the short-time inhibition following the single shock or the stimulus train *(Fig. 9A)*.

Long-time inhibition

It was observed in the case of stimulus trains of middle and high frequency (5—50 cps) when primary responses were evoked only by the first or by the first few stimulus-impulses. In this case, the spontaneous activity of the neurones is totally inhibited following the stimulus train for 30—60 sec, then the spontaneous frequency preceding the stimulation is continuously restored

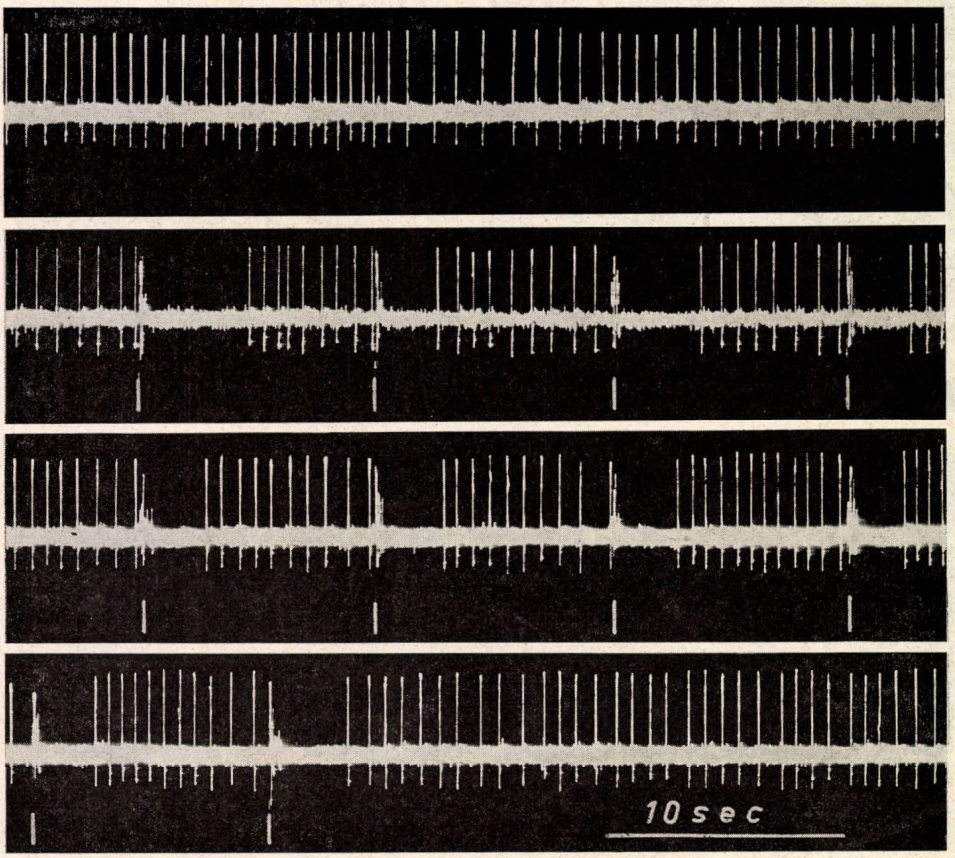

Fig. 8. Short-time inhibition at a 0.1 cps stimulus train. (The bottom vertical lines indicate the individual stimulus-impulses)

(Fig. 9B). This occurred in neurones showing either regular or irregular spontaneous activity.

In the course of the study, we experienced that on the effect of the individual stimuli of a 0.1 cps stimulus train the neurone reacted by an inhibition of 4—6 sec, and both a stimulus train of 5 cps as a train and a stimulus train of 50 cps caused a total inhibition for 15—20 sec *(Fig. 10)*. This meant practically a transition between the response types of short and long time.

In the case of the neurones showing bursting, spontaneous activity primary responses consisting of several potentials were yielded by the single stimulus-impulses. The stimulus trains of 5 cps frequency failed, however, to influence the activity pattern. In spite of this, two kinds of secondary responses could be observed following a high frequency (50 cps) stimulus train.

At one of the response types, the burst activity stopped after a 50 cps stimulus train of 1—2 sec, then the single cell discharges distributed irregularly

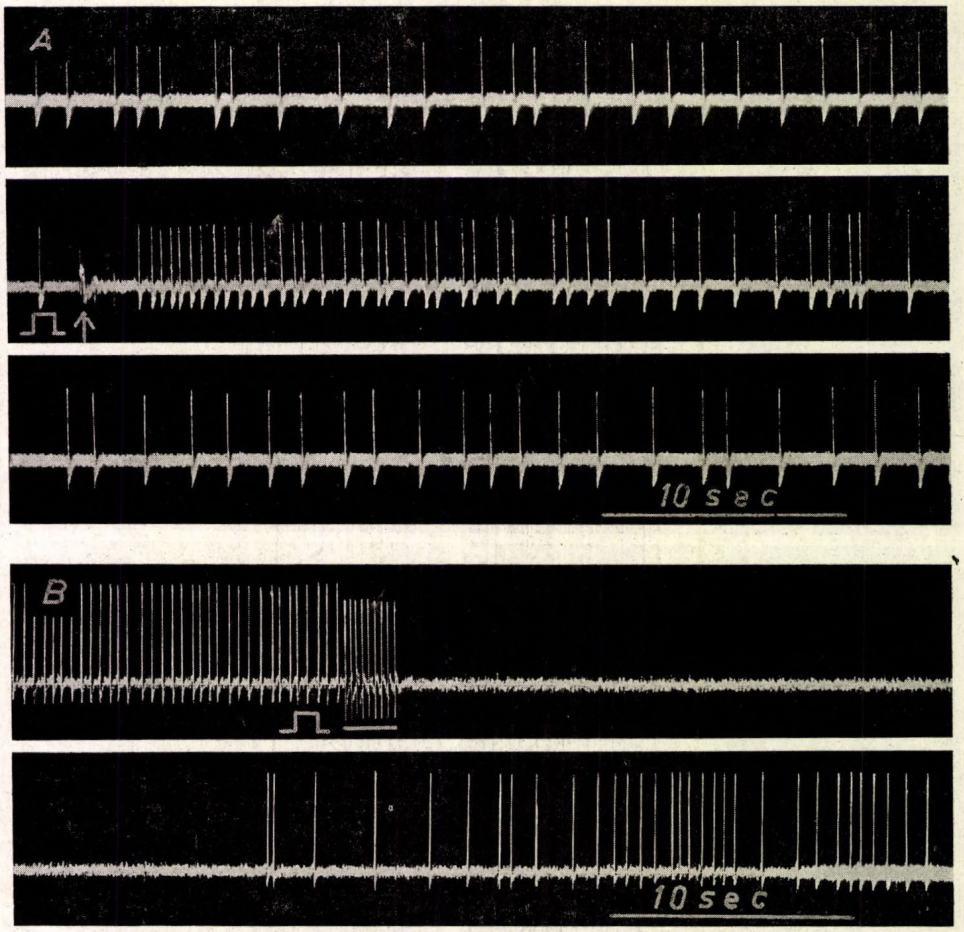

Fig. 9. A — transitional frequency-increase of the spontaneous activity after a short-time inhibition followed by a single shock, B — long-time inhibition evoked by a 5 cps stimulus train (the site of the stimulation is indicated by the arrow and the horizontal line)

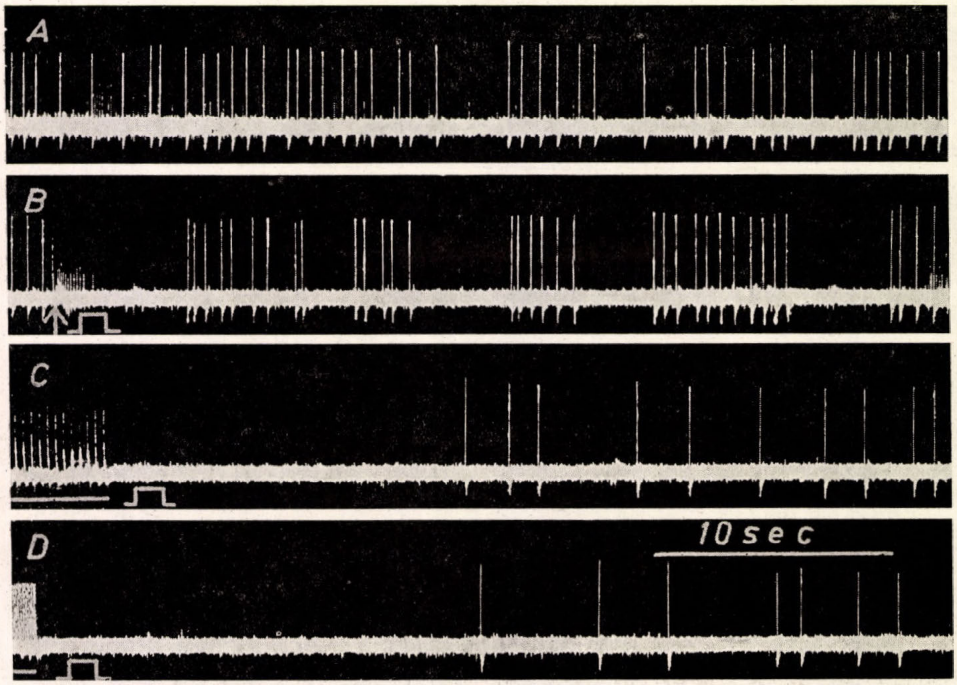

Fig. 10. Effect of single shock and stimulus train upon the spontaneous activity of a neurone. A — control, B — inhibitory responses after a single shock and C, D — the same but after 5 and 50 cps stimulus trains, respectively

were rearranged in the burst pattern corresponding to the original activity during about 170—200 sec *(Fig. 11)*. In addition to the above facts, some frequency-increase (10—20%) were also seen during the irregular activity pattern following the effect of stimulation.

At the other response type, the burst activity did not cease after the 50 cps stimulus train but the interburst-intervals shortened by about 20—30% and thus, about 60—100 sec were necessary to attain the original interburst-intervals.

Discussion

Considering the small size of the neurones composing the CNS of the Pelecypods, they are not ideal objects to investigate at cellular level and therefore we have an insufficient knowledge concerning their peculiarities. However, comparing their spontaneous activity to that of the Gastropods systematically close to them, the results were similar. Our results show that the majority of the neurones (76%) appeared silent and when some displayed spontaneous activity the average frequency was below 1 cps (0.78 cps). It is a further similarity that neurones directed synaptically (irregular activity pattern), those of pacemaker-like (regular frequency) and neurones exhibiting burst-like activity pattern (bimodal pacemaker type) (Frazier et al., 1967) were equally found here.

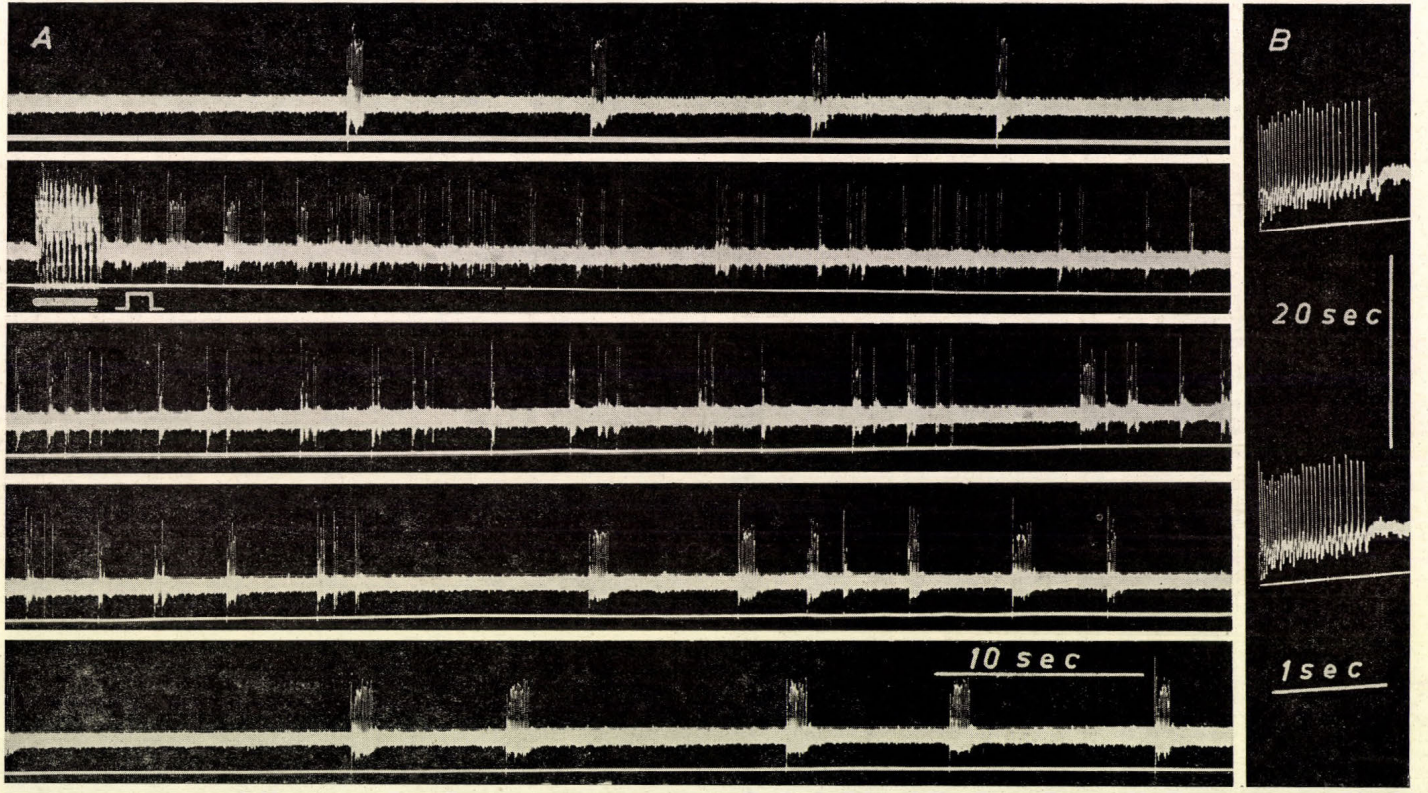

Fig. 11. A — continuous recording of the activity of a neurone. The burst character of the activity temporarily stops after a 50 cps stimulus train. B — two spontaneous bursts following each other recorded from the same neurone

Several data on Pelecypods are at our disposal to verify that the bursts of CNS origin, registrable on the nerves passing toward the effectors, do not come generally from a single neurone, and they take part in the regulation of different rhythmical muscle activity (HORRIDGE, 1961; MELLON, 1969; SALÁNKI and VARANKA, 1972; WILSON and NYSTROM, 1968). It is a rarer case when some rhythmical process is regulated by an individual neurone showing a burst-like activity, though some examples had already been presented in Gastropods (WILLOWS and HOYLE, 1968; PERETZ, 1969; KUPFERMANN et al., 1970; 1971). Apart from the question of the endogenous or exogenous generation of the bursts (MELLON, 1969; SALÁNKI and VARANKA, 1972), the demonstration of the neurones possessing a spontaneous burst-activity at cellular level raised the possibility in our investagation that in *Anodonta*, the generation of these bursts may finally be traced back to the excitement of a single neurone, at least in some cases.

According to this, the excitement of a neurone showing a burst-like activity pattern is transferred to other neurones (motoneurones) being in synaptic contact with the former, and this process results in the spreading of the excitement to the periphery, inducing there rhythmical activity. This is supported by former results (SALÁNKI and LÁBOS, 1963; SALÁNKI et al., 1968) according to which the adductor contractions and temporarily, the burst-generation of CNS origin being responsible for the adductor contractions are inhibited by the high-frequency (50 cps) serial stimulation of the CVc.

It was already shown (SALÁNKI and VARANKA, 1969) in the investigation of the activity of different *Anodonta* nerves that there is a frequency-decrease with a duration of 20 sec after the spontaneous bursts of CNS origin, while in other cases some pathways in the ganglion are inhibited for longer time, too. In the visceroparietal ganglion of *Spisula solidissima* the existence of such neurones have been shown by MELLON (1967), MELLON and MPITSOS (1967) and MELLON and PRIOR (1970) after intracellular investigations, which respond to stimulation with a spike potential and following this with a long-time (2 sec inhibition) hyperpolarization.

The fact that the spontaneous activity pattern of the neurones might be altered by a single shock or by a stimulus train means the potentiating of the discharge pattern of these neurones. So, it is one of the factors of the accomodation of the animal through the more differentiated activity of the reflex-pathways (KRISTAN, 1971).

In our present investigations the effect, in the course of which the increase of the stimulus intensity caused the decrease of the response in the neurones reacting with a burst after the stimulation, was probably the consequence of the activation of the neurones giving an inhibiting response of short duration. These neurones may be identical with those on *Spisula* (MELLON, 1967; MELLON and MPITSOS, 1967; MELLON and PRIOR, 1970). In the case of higher stimulus-threshold, these neurones become joined later in the response-circle and the decrease of the response near an increasing stimulus-intensity will result.

It is known that the cathodic stimulus is more effective than the anodic one, though, as it was shown by LÁBOS (1969) while investigating *Anodonta* CVc, that the effectivity of the stimulus depends on several factors. A stronger response with smaller latency is evoked by the more effective stimulus and in the case of stimulus trains the latency is more stable, too (ZILBER-GACHELIN

and CHARTIER, 1973). Thus, it may occur that a suprathreshold-stimulus being still effective at one of the polarities will be ineffective, subthreshold stimulus after the reversing of the polarity. In our investigations the anodic impulse proved to be more effective among the stimulating and recording circumstances employed. Since, the depolarization is a generally more effective stimulus for the neurones than the hyperpolarization, in our case the anodic stimulus resulted in probably the depolarization of the neurones and, therefore, the response was larger.

As it was seen, two types of the primary responses (1st and 2nd response type) could be distinguished by applying single shocks and stimulus trains. The first response type may be interpreted to be postsynaptic. Those experimental results, according to which also the latency-increase of the 1st type, postsynaptic response and the decrease of the response can be observed after the application of a 0.1 cps stimulus train, show a good correlation with data obtained following the transsynaptic stimulation of other invertebrate neurones (STEPHENS, 1973; ZILBER-GACHELIN and CHARTIER, 1973; KUPFERMANN et al., 1970) and it may be interpreted as a habituation-like phenomenon. The post-excitatory presynaptic depression is considered to be the cause of the phenomenon (ZILBER-GACHELIN and CHARTIER, 1973). According to other authors, the latency-increase brings about the necessity of a longer time for the summation of EPSPs during frequent stimulation in order to reach the discharge threshold (HORN and WRIGHT, 1970). In consequence of frequent stimulation, the exhaustion of the transmitter release may also be said to be the direct reason of the absence of latency-increase and of the postsynaptic response. These latter two explanations are, however, less probable, partly because of the very low stimulus-frequency employed (0.1 cps) and under normal circumstances the neurones are able to work for a long time with a higher frequency than the former one. On the other hand, similar phenomenon has been shown by ZILBER-GACHELIN and CHARTIER (1973) during the direct stimulation of *Aplysia* neurones through the somas. The habituation itself is also a well-known phenomenon in the neuronal processes of Pelecypods (PINSKER et al., 1970; CASTELLUCCI et al., 1970; LUKOWIAK and JACKLET, 1972; PRIOR, 1972 a, b; PERETZ and HOWIESON, 1973).

The latency-decrease of the responses and the increase of responses observed in some cases, primarily at stimulus trains of 0.5 cps frequency may be interpreted as a facilitation.

The fact that following the stimulation of one of the nppm nerves postsynaptic responses may be recorded from the whole ventral surface of VG, makes it possible to conclude that an extremely rich synaptic arborization and a considerable divergence of input on the input pathway on the individual neurones are present. A similar phenomenon together with a convergence can also be found in *Spisula* (MELLON, 1965). The same is supposed by HORRIDGE's (1958; 1961) and by our former results (SALÁNKI and VARANKA, 1969), according to which the burst recorded after a preganglionic stimulus expands symmetrically with respect to all of the postganglionic nerves.

It is known from morphological data that the majority of the neurones of VG are unipolar but there are multipolar cells, too, and axo-somatic and axo-axonic synapses are present (ZS.-NAGY, 1968). The thickness of the cellular layer being on the surface of the ganglion is of 50—250 μ (GUBICZA and ZS.-NAGY, 1965). Thus, the responses recorded from deeper regions than the above

thickness are not originated in great probability from somas but from the processes of the neurones. In this case, the localization of the soma fails to be represented by the place of the recording.

The nppm is a mixed nerve, since it contains motor nerves going from the VG to the siphon, as well as different fibers coming from the tactile, chemo and other receptors of the siphon. We should not exclude the possibility that like in *Spisula* (MELLON, 1972) the somas of such pressure-sensitive, primary neurones may also be localized in the VG of *Anodonta* peripheral receptor zones of which are situated in the siphon. In the case of the stimulation of the nppm, the recording of antidromic responses might be possible from the above sensory neurones as well as from the somas of the motoneurones of the siphon, and they might correspond to the primary responses of the 2nd type.

Summary

Single cell responses evoked by the stimulation of the nervus pallialis posterior maior have been investigated through extracellular microelectrode recording from the visceral ganglion of *Anodonta cygnea* L. It has been established that:

1. The majority of the neurones are spontaneously silent. The average-frequency of the neurones possessing spontaneous activity is 0.78 cps and the activity may be of different pattern.

2. At the investigation of the effectiveness of square wave impulse applied asymmetrically, it was established that this kind of stimulation results in a primary response in the silent and spontaneously active neurones, and in the majority of cases the anodic stimulus is more effective than the cathodic one.

3. The primary response of the 1st type evoked by a single shock may consist of one or more (extremely 25) spikes and its latency is longer than that of the 2nd type.

4. Generally, the increase of latency and the decrease of the response (its habituation-like feature), occasionally, the facilitation of the response were experienced after the application of stimulus trains.

5. The stimulus-frequency-following of the responses is also limited, in the case of low frequency (0.1 cps) stimulation, too (also a habituation-like phenomenon). This phenomenon is increased in the case of a stimulus-frequency of 1—5 cps.

6. After the stimulation of the nppm the spontaneously active neurones may respond with a secondary response, and with a short or long time inhibition, too, showing the plasticity of their discharge pattern.

7. Peculiarity referring to a functional structure was not found in the VG. The neurones giving the same response are diffusely localized, suggesting an extensive synaptic arborization (divergence).

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A SPONTÁN AKTIVITÁS ÉS A KIVÁLTOTT POTENCIÁLOK SEJTSZINTŰ VIZSGÁLATA TAVI KAGYLÓ (*ANODONTA CYGNEA* L.) KÖZPONTI IDEGRENDSZERÉBEN

Varanka István

Összefoglalás

Anodonta cygnea L. izolált viscerális ganglionján extracelluláris mikroelektróda elvezetéssel vizsgálták a nervus pallialis posterior maior ideg ingerlésével kiváltható egysejt válaszokat. Megállapították, hogy:

1. A neuronok többsége spontán hallgatag. A spontán aktivitással rendelkezők átlag-frekvenciája 0,78 cps, s különböző mintázatú lehet.

2. Az aszimmetrikusan alkalmazott négyszög-inger hatásosságának vizsgálatakor megállapították, hogy az a hallgatag és spontán aktív neuronokon elsődleges választ eredményez, s az esetek többségében az anódos inger hatásosabb, mint a katódos.

3. Az egyetlen ingerrel kiváltott 1. típusú elsődleges válasz egy vagy több (extrém esetben 25) spike-ből állhat, s latenciája nagyobb, mint a II. típusúé.

4. Ingersorozatok alkalmazásával általában a válaszok latencianövekedését és a válasz csökkenését (habituáció-szerű sajátságát), ritkán facilitációját tapasztalták.

5. A válaszok inger-frekvencia-követése ugyancsak korlátozott, kis-frekvenciájú (0,1 cps) ingerlés esetén is (ugyancsak habituáció-szerű jelenség). Ez a jelenség 1—5 cps ingerfrekvencia alkalmazása esetén fokozott.

6. Az nppm ideg ingerlésére a spontán aktív neuronok másodlagos válasszal, rövid vagy hosszú idejű gátlással is válaszolhatnak, ami kisülési mintájuk plaszticitását mutatja.

7. A VG-ben funkcionális struktúrára utaló sajátságot nem tapasztaltak, az azonos választ adó neuronok diffúzan helyezkednek el, nagymértékű szinaptikus arborizációt (divergencia) feltételezve.