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"The Electrical Phenomena accompanying the Process of Secretion in the Salivary Glands of the Dog and Cat."

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(Abstract.)

The glands examined were the submaxillary and parotid of the dog and cat, and in all of these we have determined that the process of secretion is accompanied by definite electrical changes; as, however, the submaxillary gland both in the dog and cat has been more thoroughly examined than the parotid, the present communication is confined almost entirely to the former.

The chorda tympani and sympathetic nerves were exposed in the usual manner, divided, and the peripheral ends arranged for stimulation, a canula being placed in Wharton's duct. The submaxillary gland having been exposed was led off in the following manner. One non-polarisable electrode was placed on the superficial or cutaneous aspect of the gland, and the second electrode so arranged in the wound as to touch the deep surface of the gland as close to the hilus as possible without pressing on the duct.

A Thomson galvanometer of high resistance was used.

Electrical Condition during Rest.

Dog.—The cutaneous surface of the gland is in the great majority of cases negative to the hilus, both when examined as above described and also when the gland is removed from the animal and led off.

In four experiments amongst twenty-four, the outer surface of the gland was positive. In two cases the outer surface was at first positive, but subsequently became negative, and in one case it was at first negative but subsequently became positive.

The electromotive force of the current of rest varies very much both in different cases and in the same case at different times; thus in the former case it may vary from $\frac{1}{10}$ volt to $\frac{1}{500}$ volt, but owing to a variety of structures (muscles, &c.) being unavoidably injured in the preparation, not much stress can be laid on this point.

Cat.—Out of twenty experiments on the submaxillary gland, in fifteen the surface of the gland was positive to the hilus, in three the surface of the gland was negative, in one the surface was at first negative and subsequently became positive, and in one the surface was at first positive and subsequently became negative to the hilus.

Hence, although a corresponding amount of injury is inflicted on the tissues in the case of the cat as in the dog, yet on the whole the resting current is opposite in its sign in the two cases.

Excitatory Changes.

Dog. Chorda Tympani.—On throwing an induction current into the chorda tympani, a very well-marked deflection of the galvanometer is *always* observed of a sign indicating that the outer surface of the gland becomes *negative* to the hilus. Although in different dogs the amount of this deflection varies, yet never have we failed to obtain it.

Frequently this variation is not the sole one observed, its course being interrupted by a second deflection showing the outer surface of the gland to become positive. This second variation, however, is by no means always observed, and more especially it is not seen if the first or main phase is very large, being then indicated only by a slight temporary arrest in the deflection caused by the first phase. The latent period of the variation is short, being about 0·37″, as measured by the capillary electrometer. The deflection quickly reaches a maximum and begins to diminish before the cessation of the excitation, returning quickly towards zero, but as a rule leaving a slight after-effect.

Atropine, in doses of 5—10 mgrms., abolishes the main phase of the chorda variation in from 2—3 minutes from its injection into the pleura. In those cases in which this phase only had been observed,

frequently after such a dose of atropine the second phase (*i.e.*, outer surface of gland positive to hilus) is seen on excitation of the chorda, although previously not detected, owing to the magnitude and rapidity of the deflection caused by the first or main phase.

This second phase is more refractory towards atropine than the main phase, although ultimately abolished by it in large doses.

Excitation of Sympathetic causes well-marked changes of potential in the gland structures which are very different to those produced on excitation of the chorda; the latter have a very short latent period, are readily abolished by atropine, and are of such a sign as to cause the outer surface of the gland to become negative, occasionally followed by the outer surface becoming positive.

Excitation of the sympathetic, however, produces after a very long latent period an electrical effect very refractory as regards the action of atropine on it, and of such a sign that the outer surface of the gland becomes *positive* to the hilus.

Further, the course of the variation is very slow, and its amplitude is much less than that of the chorda variation. Thus in one case on excitation of the sympathetic a deflection of 62 was obtained, the chorda giving a deflection of 140 with $\frac{1}{9}$ shunt.

Atropine in small doses has apparently no effect on the sympathetic variation, but in large doses, 40—100 mgrms., it is not without effect, at first producing great lengthening of the latent period, and then steadily diminishing the amplitude of the variation, although after even 100 mgrms. a slight variation, *i.e.*, 10—15 divisions, is still perceptible.

Cat. Chorda tympani.—In the cat, excitation of the chorda causes an electrical variation of such a sign that the outer surface of the gland becomes negative to the hilus, but whereas in the dog, a second phase was on the whole not observed in the majority of cases, in the cat a second phase is usually present, and very frequently is greater in amount than the first phase. Further, in a few cases, the first phase (*i.e.*, outer surface of gland negative) was very small indeed, *i.e.*, less than 20 divisions, and in one case it was absent, the chorda giving a pure second phase. These varieties observed in the variations are largely dependent on the nature of the accompanying secretion.

In these cases in which the first phase was large, the secretion was very watery, and if the secretion obtained was viscid the electrical variation consisted of a small first phase and a large second phase.

Atropine in doses of 2—20 mgrms. abolishes the first phase of the chorda variation, leaving the second phase, as in the dog, and this second phase requires a larger dose to abolish it, *i.e.*, 20—40 mgrms.

Excitation of the sympathetic in the cat produces an electrical effect resembling more the chorda effect of the cat than the sympa-

thetic effect of the dog. Thus the usual effect is a deflection similar to the chorda effect of the cat, *i.e.*, diphasic, but with this difference, that the first phase is usually larger than the second phase, and not as in chorda excitation, the second larger than the first. This variation is obtained if the accompanying secretion be watery in character, but if, as occasionally happens, it be viscid, then the second phase is larger, and the first phase smaller in amount.

Atropine in small doses abolishes the first phase, and in doses of 10—40 mgrms. the second phase, thus showing a very great difference between its action on the sympathetic variation in the cat and dog respectively.

Thus to sum up our results :—

In the submaxillary of the dog excitation of the chorda produces a copious slightly viscid secretion, and the electrical effect consists of a large first phase, the second phase being small, and although not always observed is probably always present.

In the cat a similar excitation produces a copious viscid secretion, and the electrical effect is diphasic, the second phase being usually the larger.

In the dog, excitation of the sympathetic produces a scanty viscid secretion, and the electrical effect consists of a pure second phase.

In the cat, excitation of the sympathetic produces a very copious and but slightly viscid secretion, and the electrical effect is diphasic, the first phase being usually the larger.

In the parotid the results obtained are similar to those in the submaxillary.

In the dog excitation of the tympanic plexus causes the surface of the gland to become negative to the hilus, and the variation is readily abolished by atropine. Excitation of the sympathetic causes the surface of the gland to become positive to the hilus, and the variation is not readily abolished by atropine.

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