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# The Respiratory System and Respiratory Technique of Hydroporus palustris (L.) (Coleoptera, Dytiscidae)

by **M. Gilbert***

Abstract: The structure and composition of the tracheal system of *Hydroporus palustris (L.)* were analysed on the basis of cross-sections. The results cover the structure and arrangement of the spiracles, as well as the position of certain segments of the tracheal system, e.g. on the oesophagus or on muscular systems performing respiratory movements, and their functioning. These muscular systems were studied in conjunction with the clearly developed endoskeleton (es; Fig. 15) of the beetle, as well as the subelytral area (sa), which, together with the tracheal system, serves as an air reservoir. Tests were performed to analyse the adaptation of the beetle's respiratory system to its aquatic environment, particularly the functioning and performance of the physical gill.
The results obtained enabled a theoretical model of the beetle's respiratory technique to be developed, which is based on and supported by the structure and position of the individual components of the tracheal system.

Key Words: Water beetle – Dytiscidae – *Hydroporus palustris* – tracheal system – spiracles – muscular systems – experiments.

## Introduction

The state of scientific research in this field of the Dytiscidae has not advanced very far, except in the case of *Dytiscus marginalis L.*, whose spiracle structure and structure of the respiratory system was dealt with by Alt (1912). His publication gives an excellent description of the spiracles and the tracheal system. The essential results of this work can also be found in the Monograph of *D. marginalis L.* by Korschelt (1924).

Work regarding the respiration of the Dytiscidae has also been conducted by Brocher (1916) Ege (1915), Heberdey (1938), Krogh (1920) and Wesenberg-Lund (1912). Heberdey (1938) conducted a number of interesting experiments with respect to the significance of the air in the subelytral area for the beetle's respiration. Wesenberg-Lund (1912) described the respiratory technique of *D. marginalis L.* with 10 items, basing his comments mainly on the structure and size of the spiracles, and also on experiments with the beetle's subelytral air.

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* The following paper is part of the paper I submitted for the "Jugend forscht" Science Competition 1983 for young people, at the age of 17, when I was still at school. (Foundation "Jugend forscht", Notkestrasse 31, 2000 Hamburg 52)

However, there are only very few and not very exhaustive publications regarding the respiration and respiratory technique of the Dytiscidae.

## Method

The structure of the beetle's tracheal system was reconstructed with the help of cross-sections. For this purpose, a sample was first fixed, and then embedded in methacrylacidester (altogether two samples were successfully cut). A series of cross-sections was cut with the help of a rotationmicrotome (Fa. Jung AG, Heidelberg), each having a thickness of 10 µm. The exact embedding procedure is described by HIRSCH & BOELLARD (1959/60).

| | | |
|---|---|---|
| Preparation: | in Bouin-Dubosq-Brasil solution | |
| Fixing: | – Bouin-Dubosq-Brasil solution | 24 hours |
| | – 90% diluted alcohol | 15 min. |
| | – 70% diluted alcohol | 1 day to several days |
| Dehydrating: | acetone (extremely pure) | 5 × 1 hour |
| Embedding: | 1st mixture: | |
| (under | methyl methacrylate | 10 ml |
| extractor) | + benzoyl peroxide | 0.2 g |
| | 2 hours at room temperature | (22° C) |
| | 2nd mixture: | |
| | methyl methacrylate | 10 ml |
| | + benzoyl peroxide | 0.2 g |
| | + polyethylenglycol 1500 | 5 g |
| | Leave overnight in temperature chamber at 50° C. Leave the fully polymerised block at least one day at room temperature. | |
| Block Cutting: | Cut blocks to fit the gripping device (microtome). with a 5:1 mixture of 96%- alcohol and 2-butoxy-ethanol | |
| Bonding Drying: | overnight, in the temperature chamber at 37° C | |
| Placing of cover slip: | Eukitt | |

The average oxygen absorption of a beetle *(H. palustris (L.))* through the air bubble (physical gill) was measured in the following test setup (Fig. 23):
Water, dispersed with air, flows from a reservoir (r) into the test basin (tb) containing the beetles (5 samples). With the help of a clip (c), the flow rate was adjusted to 30 ml/h. From the test basin (tb), the water flows into a Winkler bottle (W2), and from there, into a measuring cylinder, via a large funnel. The entire apparatus has to be free from air bubbles. Throughout the duration of the test, the water temperature was exactly 18° C. At the end of the test, you remove the Winkler bottles (W1, W2) to the left and to the right of the test basin and close them up. The right-hand bottle (W1) contains the water with the higher oxygen content, the left-hand one (W2), the water with the lower oxygen content, after passing through the test basin (tb). By measuring the oxygen content of the two bottles, you obtain the difference between the two, which is equivalent to the quantitiy of oxygen used by the beetles.

## Results

*Hydroporus palustris (L.)* (Fig. 1) has a length of 3.5 mm and lives in stagnant waters with submersed plant growth, usually situated in the vicinity of a forest (Fig. 2).

### Spiracles

*H. palustris L.* has 10 pairs of spiracles all of which are dorsally displaced (Fig. 3).

In the posterior part of the prothorax, in the lateral area, there is one pair of relatively large prothoracic spiracles (ps) which are made up of two parts (Figs 4–5): the first is the precedent atrium. Below the atrium, the mouth of the spiracle controls the second part, the opening that leads into the tracheal main trunk. At the tracheal main trunk, a muscle (cm) is attached to the tracheal wall which pulls slightly at an angle, and in the lateral direction. Contraction of this muscle (cm) closes the mouth of the spiracle. The prothoracic spiracle (ps) does not have a dust filtering mechanism.

The existence of a pair of mesothoracic spiracles could not be determined from the cross-sections, because a number of sections in the mesothoracic area was destroyed in the cutting procedure. Yet, if you

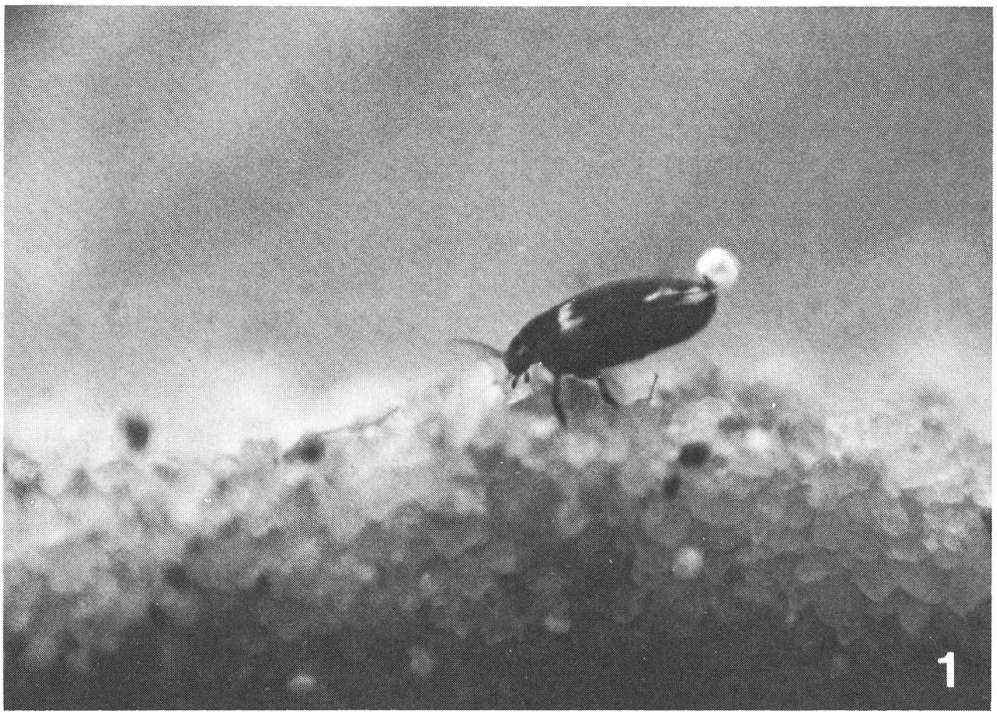


Fig. 1: *Hydroporus palustris (L.)* underneath the water surface (6,8 ×).


Fig. 2: Living space of *H. palustris (L.)* (close to 6105 Ober-Ramstadt, F.R.G.).

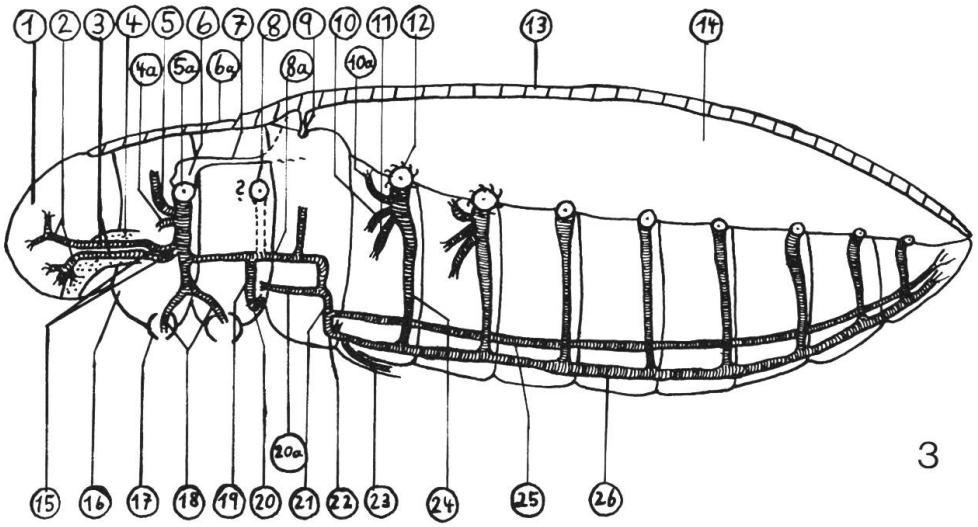


Fig. 3: *H. palustris (L.),* longitudinal section of the tracheal system. 1. head; 2 trachea of the head; 3 visceral longitudinal trunks (terminology of the cross-sections: vilt) at the oesophagus (oe); 4 oesophagus (oe); 4a lateral tracheal branch (lb) of the prothoracic spiracle; 5 dorsal tracheal branch (db) of the prothoracic spiracle; 5a prothoracic spiracle (ps); 6 air cavity of the prothoracic spiracle; 6a pronotum; 7 cuticle tube; 8 mesothoracic spiracle; 8a visceral longitudinal trunk from the prothoracic spiracle; 9 metathoracic lock; 10 lateral tracheal branch (lb) of the first abdominal spiracle; 10a dorsal tracheal branch (db) of the first abdominal spiracle; 11 visceral tracheal branch (vib) of the first abdominal spiracle; 12 first abdominal spiracle (1st as); 13 elytron (e); 14 subelytral area (sa); 15 visceral tracheal branch (vib) of the prothoracic spiracle; 16 prothorax (following two segments: meso- and metathorax); 17 coxa; 18 first and second leg trachea; 19 ventral branch of the mesothorax; 20 ventral commissure of the mesothorax; 20a lateral longitudinal trunk of the metathorax; 21 ventral branch of the metathorax; 22 ventral commissure of the metathorax; 23 third leg trachea; 24 ventral tracheal branch (vb) of the first abdominal spiracle. 25 neural longitudinal trunk of the abdomen; 26 ventral longitudinal trunk of the abdomen.

open the thorax under the microscope, you will be able to see a pair of mesothoracic spiracles (Fig. 3).

The first abdominal spiracle (1st as or s) is characterized by a sturdy dust filtering system ahead of the spiracle's atrium (Figs 6–8). This is attached to a lever-type cuticle structure (cl), connected to the pleural edge (pe) by a muscle (cm). The pleural edge (pe) is slightly more sclerotised in this area and has a toothed segment. A formation of mating teeth can be found on the cuticle lever (cl). Contraction of the muscle (cm) causes the cuticle lever (cl) to be lifted, the two toothed segments are now directly opposite eachother, and engage. The closing muscle (cm) is relaxed. As a result of the contraction, the slot-shaped mouth of the spiracle is closed by a dorsal movement of the under lip. Opening is achieved by a dorsal muscle (cm) acting on the spiracle, which displaces the cuticle lever (cl) slightly towards the dorsum, thus realising

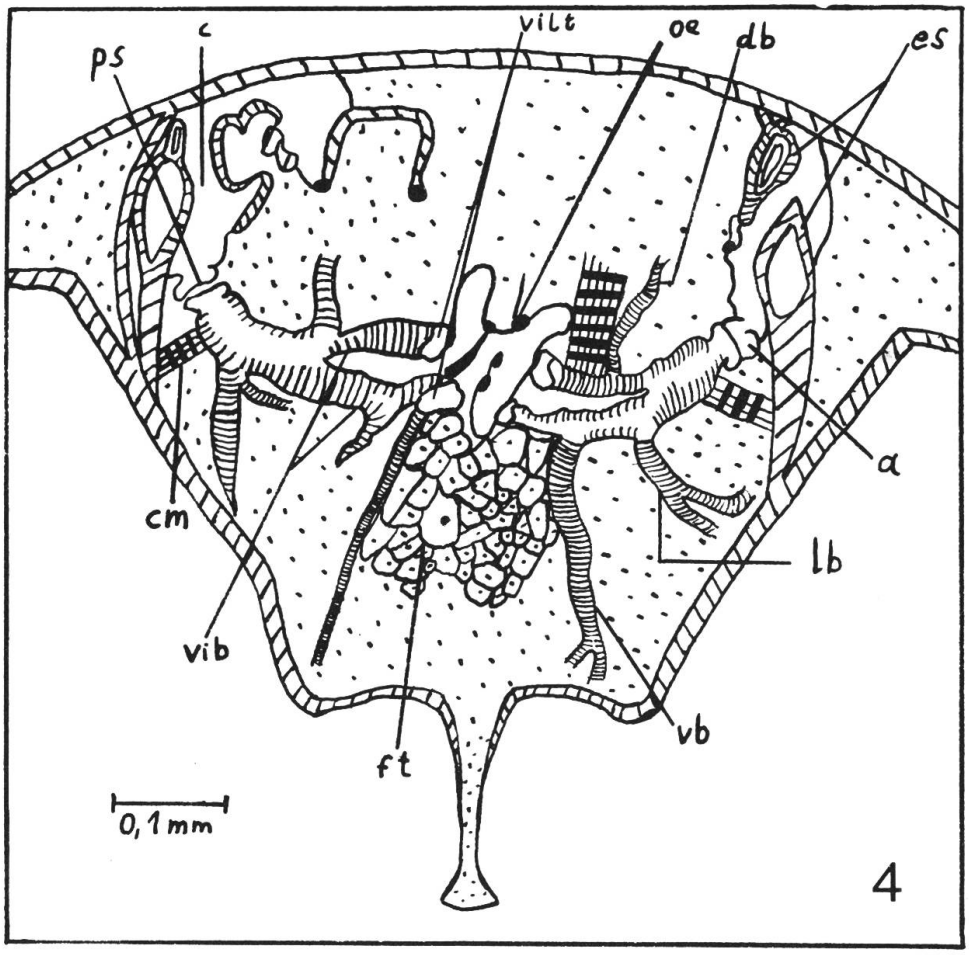


Fig. 4: *H. palustris (L.)*, cross-section of the prothorax (125 x), a = atrium, c = cavity, cm = closing muscle, db = dorsal branch, es = endoskeleton, ft = fat tissue, lb = lateral branch, oe = oesophagus, ps = prothoracic spiracle, vb = ventral branch, vib = visceral branch, vilt = visceral longitudinal trunk.

the two toothed segments. The first abdominal spiracle has an oval structure, and is slightly larger than the second one (Fig. 9). The latter is circular in shape and differs from the first one only with regard to the closing mechanism, which takes the form of a muscle (cm) which is attached to the wall of the spiracle in the atrium area and passes the tissue ventrally. In the venter, the muscle acts upon a cuticle clip formed by the sternite. Contraction of this muscle (cm) has the effect of a spring clip.

The size of the abdominal spiracles decreases continously down to the eigth abdominal spiracle (Fig. 3). The remaining abdominal spiracles differ from the first and second abdominal spiracles in that there

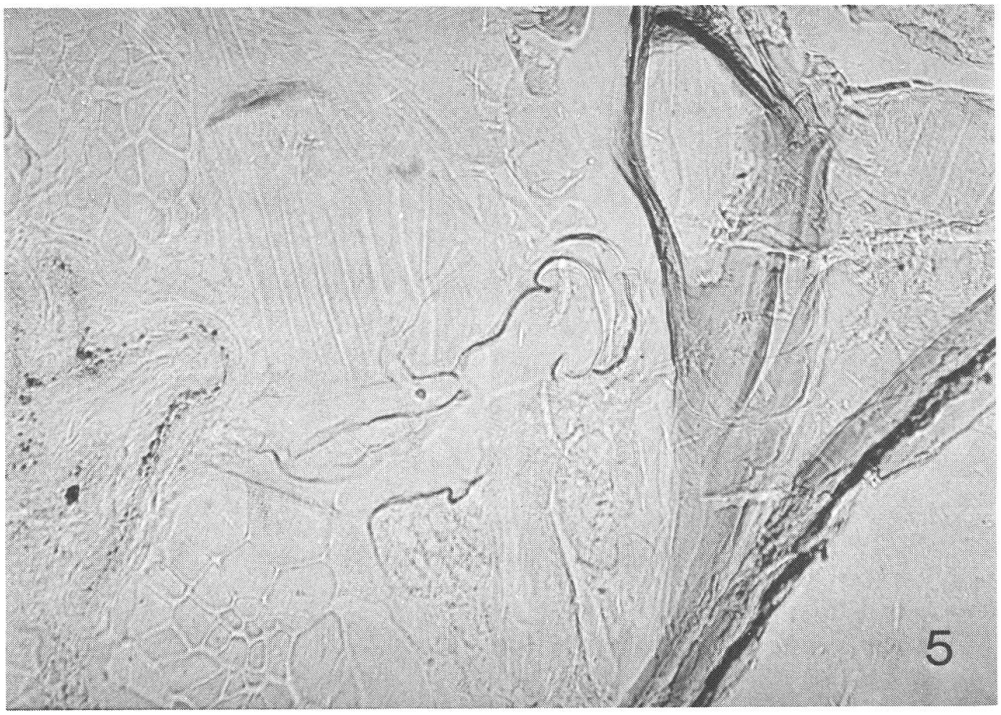


Fig. 5: *H. palustris (L.)*, cross-section of the prothoracic spiracle (207 ×).

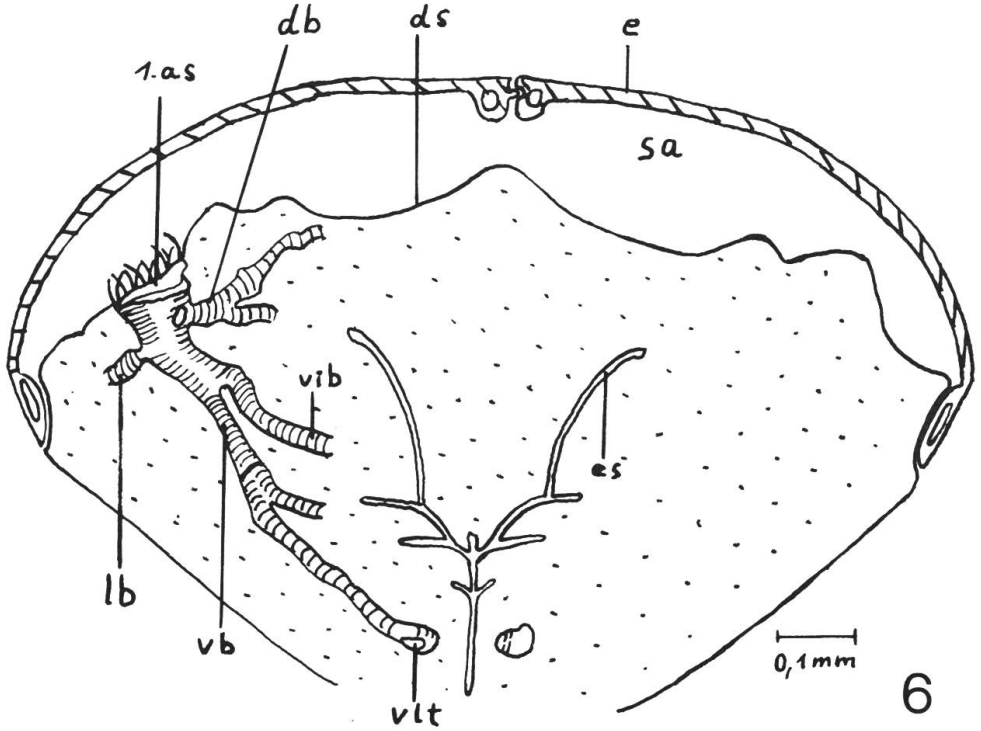


Fig. 6: *H. palustris (L.)*, cross-section of the first abdominal segment (56 ×), 1. as = 1st abdominal spiracle, db = dorsal branch, ds = abdominal tergite(s), e = elytron, es = endoskeleton, lb = lateral branch, sa = subelytral area, vb = ventral branch, vib = visceral branch, vlt = ventral longitudinal trunk.

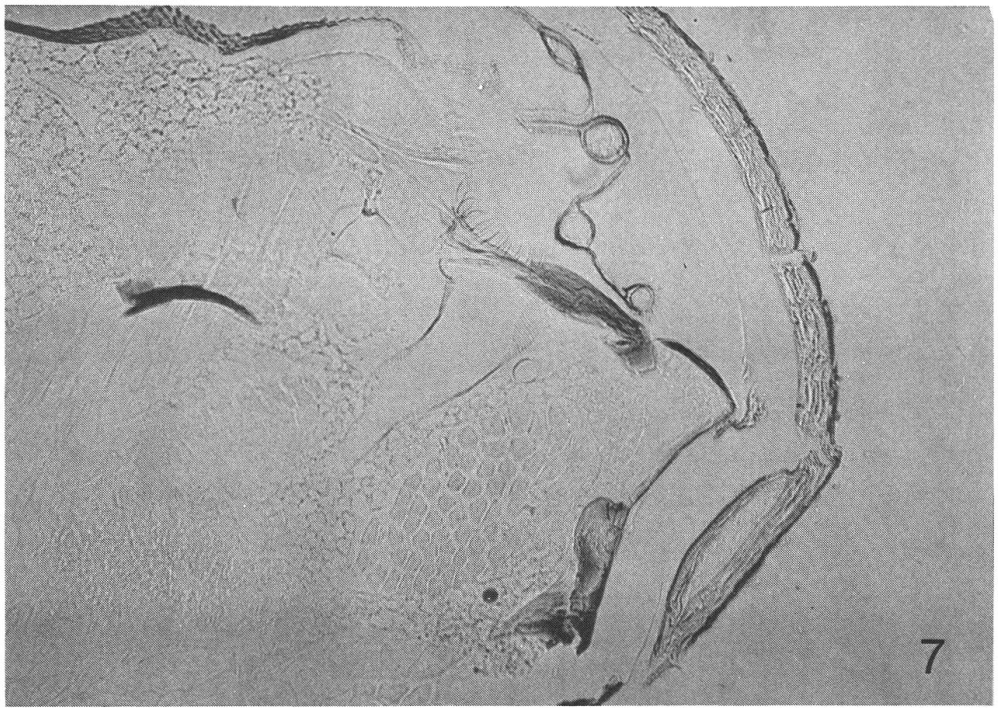


Fig. 7: *H. palustris (L.),* cross-section of the first abdominal spiracle (129,4 ×).

is no dust filtering system. The last spiracles have the most simple structure of all, which, although they still have an atrium, merely look like outlet openings (Fig. 10). These spiracles are also closed by a muscle acting like a spring clip.

**Structure and course of the tracheal system**

The tracheal sytem of *H. palustris (L.)* is a secondary complex system, i.e. a continuous system (Fig. 3). In describing the tracheal system, I will start with the prothoracic spiracle (Fig. 4). The prothoracic spiracle (ps) opens into a cavity (c) lined with chitin, formed by the endoskeleton. From the beginning of the mesothorax, this cavity (c) narrows into a thin cuticle tube (Figs 11; 3) which leads, at the end of this segment, into the mesothorax "slotted areas". The lateral slotted areas of the mesothorax have a direct connection with the metathorax, which is, after all, the extreme part of the subelytral area (sa), (Fig. 3). The prothoracic spiracle (ps) is thus directly connected with the mesothorax and the metathorax, and eventually with the subelytral area (sa) and the air in it.

The tracheal trunk leading away from the prothoracic spiracle (ps) branches into a lateral (lb), a dorsal (db), a ventral (vb) and two visceral

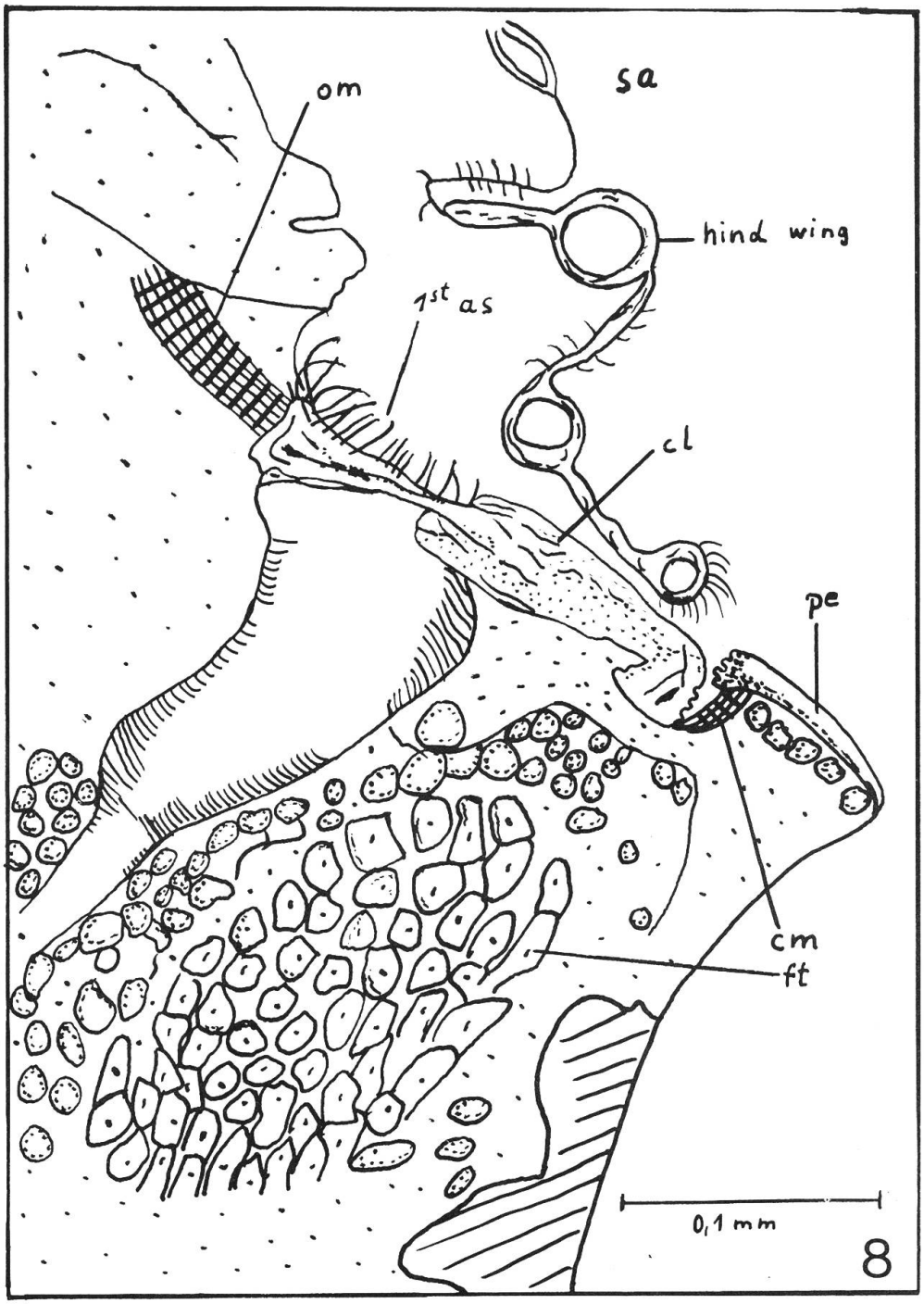


Fig. 8: *H. palustris (L.),* cross-section of the first abdominal spiracle with its closing mechanism (290 ×), 1st as = 1st abdominal spiracle, cl = cuticle lever, cm = closing muscle, ft = fat tissue, om = opening muscle, pe = pleural edge, sa = subelytral area.

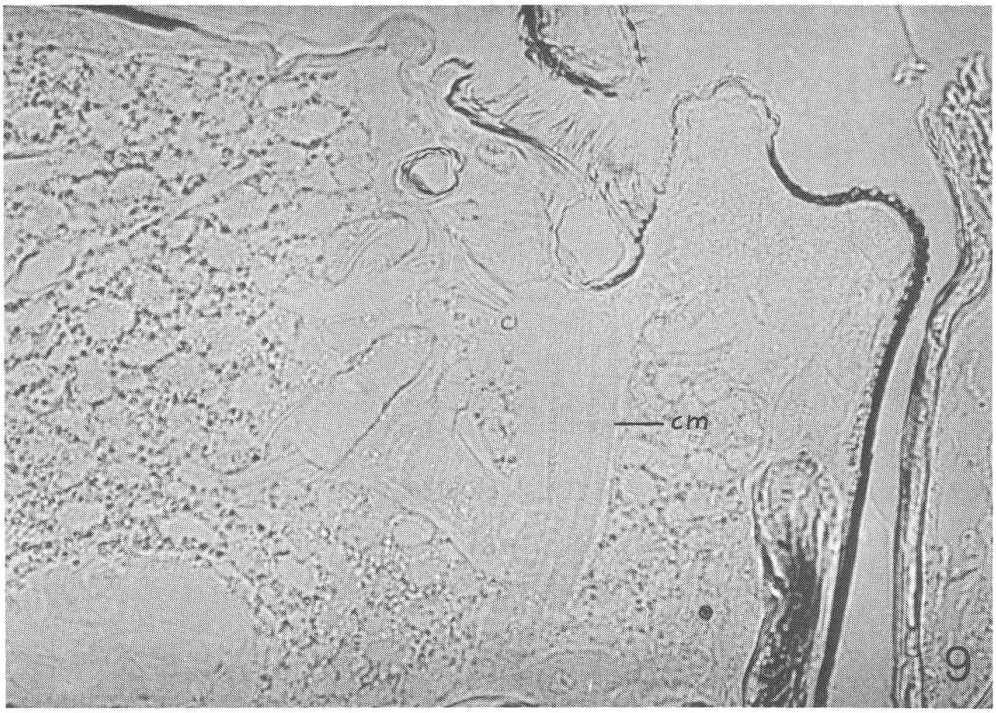


Fig. 9: *H. palustris (L.)*, cross-section of the second abdominal spiracle (207 ×), cm = closing muscle.

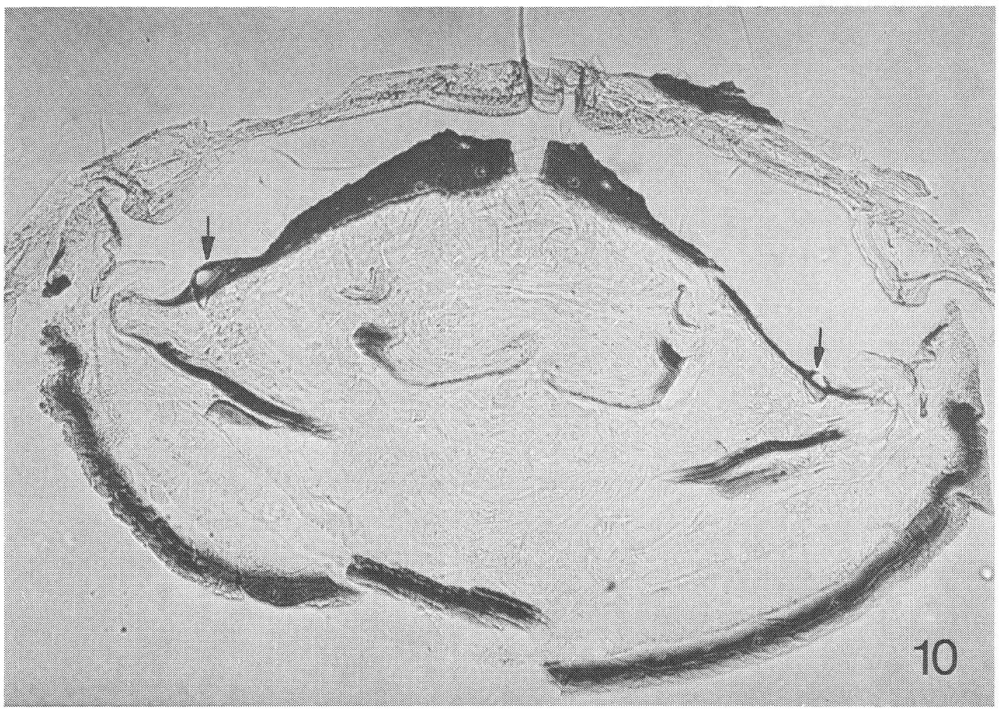


Fig. 10: *H. palustris (L.)*, cross-section of the eighth pair of abdominal spiracles (129,4 ×).

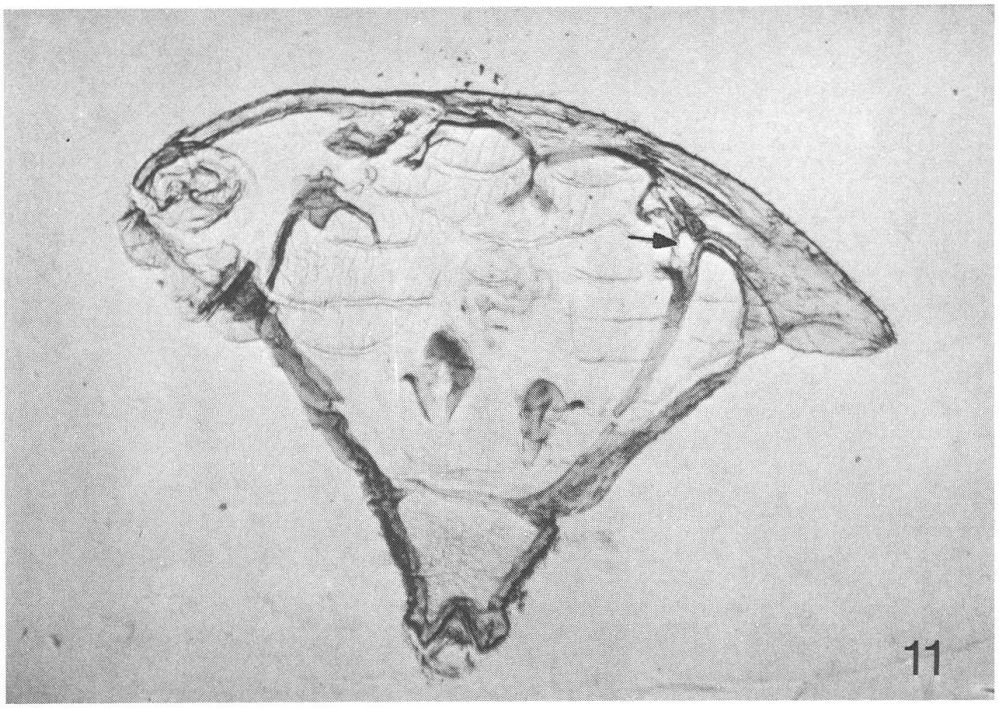


Fig. 11: *H. palustris (L.),* cross-section of the mesothorax and the cuticle tube (52 ×).

tracheal branches (vib) just below the spiracle (Fig. 4). With the exception of the two visceral tracheal branches (vib), all other branches divide further several times, and lead to the different tissues. From the ventral tracheal branch a leg trachea branches towards the front extremities (Fig. 3). The two visceral tracheal branches of the spiracle lead into two visceral longitudinal trunks (vilt) situated directly at the oesophagus (oe), (Figs 4; 12). Those four longitudinal trunks lead directly to the head and split up there (Fig. 3). The position of the visceral longitudinal trunks (vilt) in the immediate vicinity of the oesophagus (oe) indicates that the latter's peristaltic motion positively supports air transport in the longitudinal trunks. Thus, the longitudinal trunks distribute air not only by way of diffusion, but are subject to positiv pumping action and probably not only during food intake. This fact of a permanent peristaltic motion of the oesophagus was investigated, e.g, in carabids (Smrž, unpublished).

In the visceral area, a longitudinal trunk (8a) divides from the ventral branch of the prothoracic spiracle towards the abdominal area (Fig. 3). The longitudinal trunks of both prothoracic spiracles merge in the final section of the mesothorax via ventral branches (19), by way of a ventral commissure (20). In this area the mesothoracic spiracles prob-

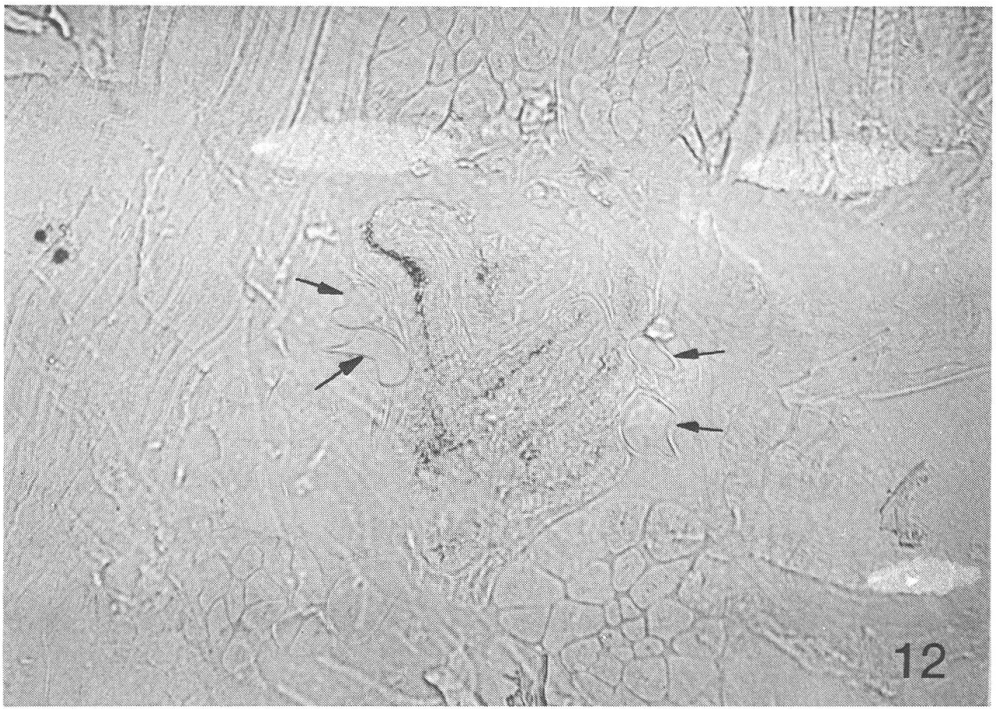


Fig. 12: *H. palustris (L.)*, cross-section of the four visceral longitudinal trunks in the immediate vicinity of the oesophagus (207 ×).

ably have a connection with these visceral longitudinal trunks. The visceral longitudinal trunks (8a) then pass above their ventral branches, into the middle of the metathorax, where they merge by way of transverse branches with slender lateral longitudinal trunks (20a). These again are connected at the end of the metathorax by way of ventral branches (21) and a ventral commissure (22). Ahead of the merging point visceral longitudinal trunks (25) branch from the ventral branches (21) of the lateral longitudinal trunks (20a). From the third abdominal segment, these trunks start declining towards the ventrum, and become neural longitudinal trunks (25), supplying the nervous system. The ventral commissure (22) in the metathorax is formed by two merging ventral longitudinal trunks (26), (Fig. 3). From the beginning of the abdomen, two separate ventral longitudinal trunks lead down to the tip of the abdomen (Fig. 13). The ventral tracheal branch of the first abdominal spiracle finally ends in the ventral longitudinal trunk of the corresponding side, with which it is connected (Fig. 3; 6). In this way, all spiracles of the abdomen have a connection with the corresponding ventral longitudinal trunk (26). The remaining tracheal branches of the spiracles branch once more, and supply the different tissues.

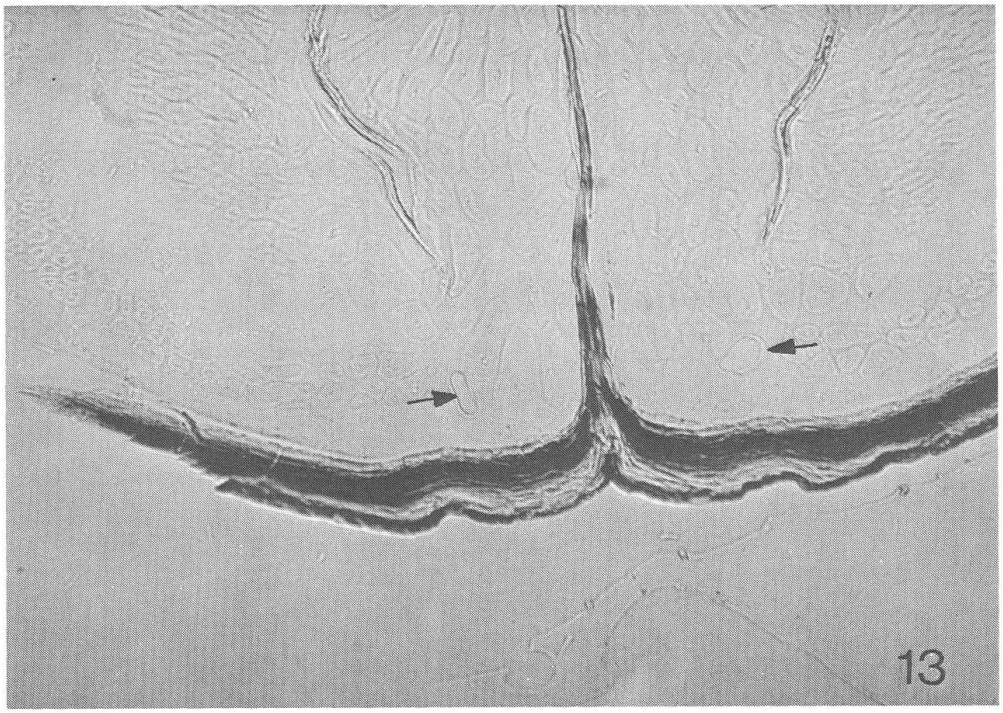


Fig. 13: *H. palustris (L.)*, cross-section of the ventral longitudinal trunks (207 ×).

## Respiration model

This knowledge of the course, the arrangement and the structure of the individual components of the entire system enabled a hypothetical model of the dynamics of the beete's respiration to be developed. I emphasize that this following model is only hypothetical and is based on the beetle's short stay at the water surface (5 to 10 seconds) where diffusion cannot be the only respiration mechanism.

As soon as the beetle has come to the water surface and adopted its breathing position, it folds down its last abdominal segment. This causes a small gap to the generated, which establishes a connection between the subelytral area (sa) and the ambient air. Since the beetle does not release any air before coming to the water surface, or while it is still under water, the air has to be expired at the surface (Fig. 14). Hence the first respiratory movement of the tracheal system is an active expiration, caused particularly by contraction of the dorsoventral muscles (dvm) of the abdomen, assisted by the dorsolateral (dlm) muscular system (Figs 15–17). Contraction of the dorsoventral muscles of the metathorax has an additional effect on the trachea. In all probability, the blood pressure also increases during expiration. During this pro-

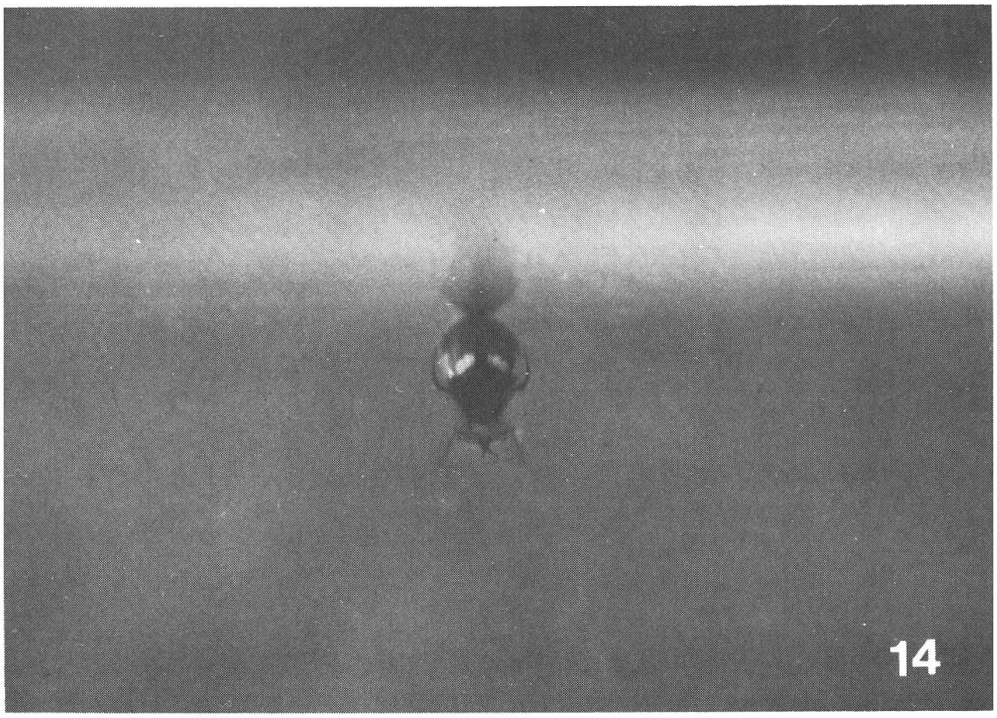


Fig. 14: *H. palustris (L.),* breathing position at the water surface (4,5 ×).

cess, the abdominal tergites (ds) are pulled down and an increased pressure is produced in the tissue, which causes the trachea to fold together almost completely (Fig. 17). Expiration, however, does not take place altogether without direction and through all spiracles at once. I am assuming, particularly in the case of *H. palustris (L.),* that the abdominal spiracles 1 to 5 are closed before expiration, while the spiracles 6 to 8 remain open (Fig. 18). At this point, contraction of the muscular systems of the abdomen and metathorax occurs, resulting in the abdominal tergites (ds) being lowered, and causing an increased tissue pressure. The trachea are now collapsed completely whereby the air from the tracheal trunks and the branches of the closed spiracles has to escape by some way other than the mouth of the spiracle. This is where the ventral longitudinal trunks (vlt) come into effect. Through these, air flows to the last three pairs of abdominal spiracles, from where it escapes into the subelytral area (sa), but also to a large extent, through the expiration slot (es; physiological term in relation to the respiration phase). During this expiration process, contraction of the abdomen starts at the first 5 segments of the abdomen, and continues with the remaining three segments shortly afterwards. This eliminates the problem of the expiration spiracles being closed off by their tracheal trunks to early. It

is considered highly probable that the thoracic spiracles are closed as well during expiration.

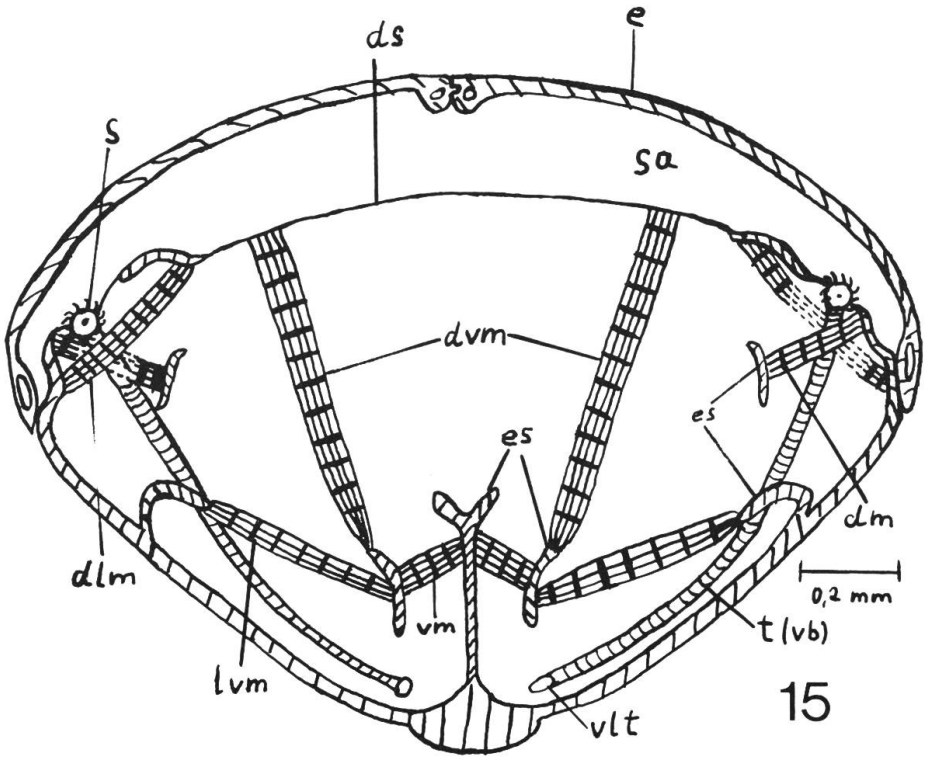


Fig. 15: *H. palustris (L.)*, cross-section of the muscular system of the abdomen (54 ×), dlm = dorsolateral muscular system, dm = dorsal muscular system, ds = abdominal tergite(s), dvm = dorsoventral muscles, e = elytron, es = endoskeleton, lvm = lateral-ventral muscular system, s = spiracle, sa = subelytral area, t(vb) = trachea (ventral branch), vlt = ventral longitudinal trunk, vm = ventral muscular system; in reality the muscular systems lvm and vm are not situated in the same segments where dvm, dm and dlm are localized.

This first expiration phase is followed by a second phase (Figs 19–20), during which the spiracles 6 to 8 are also closed and the abdominal tergites revert to their rest position. Contraction of the dorsal (dm), lateral-ventral (lvm) and ventral (vm) muscular system (Fig. 19) causes the abdominal tergites (ds) to be moved to a position above their rest position, towards the elytra (e). In this position the trachea (t) remain collapsed, because they are all closed by the spiracles. In all probability, the tissue pressure is supported by an increased blood pressure during this movement. In this phase of expiration, the beetle causes the subelytral air to be breathed out through the expiration slot (es; physiological term in relation to the respiration phase), by means of a volume reduction of the subelytral area (sa). Part of the subelytral air, however,

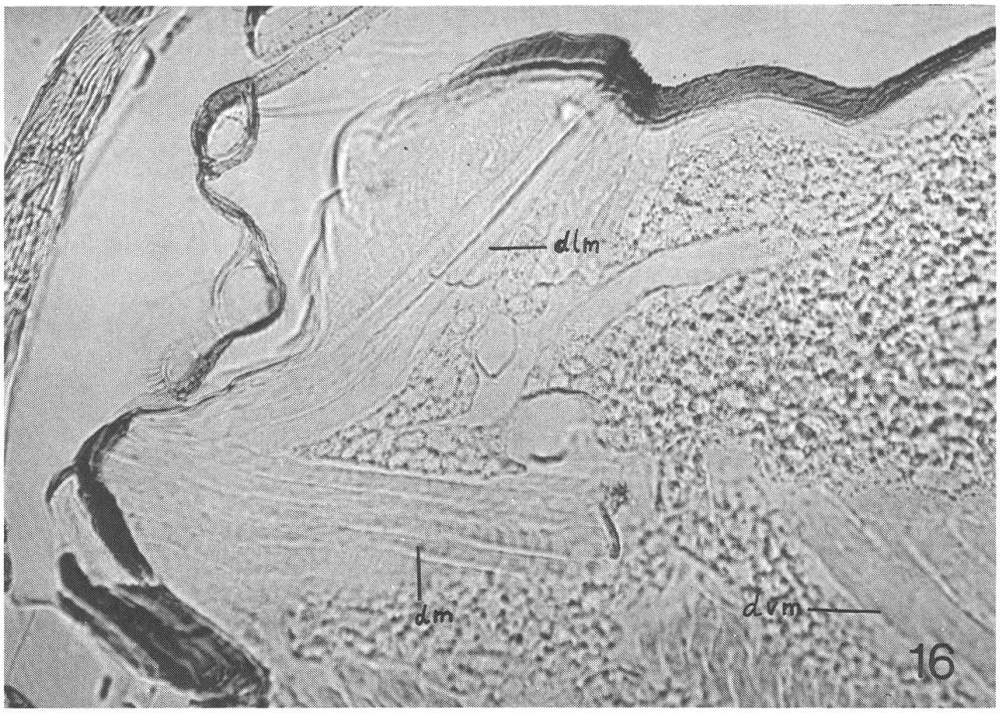


Fig. 16: *H. palustris (L.),*, cross-section of the dorsal (dm) and dorsolateral muscular system (dlm), dvm = dorsoventral muscular system (207 ×).

is retained. Still, I believe, the beetle is able to breathe out two thirds of its subelytral air in this way.

Next follows the second part of the respiration procedure, that is, inspiration (Figs 21–22). The beetle's muscles are relaxed, and the first and second pairs of abdominal spiracles (s) are opened shortly afterwards. The abdominal tergites (ds) return to their original position. The vacuum thus generated causes atmospheric air to be sucked into the subelytral area (sa) by way of the inspiration gap (ig; physiological term in relation to the respiration phase). Atmospheric air will also flow through the deepened spiracle channels, and is sucked in through the opened first two pairs of abdominal spiracles. The reason why these first two pairs of abdominal spiracles are used as inspiration spiracles is first of all that these are provided with a dust filtering system which eliminates major dust particles from the air, and secondly, that these spiracles have the largest opening diameter.

Next, the trachea (t) are extended once more, by means of the taenidium and the entering air. Approximately two thirds of the tracheal system are now filled with nearly atmospheric air. The remaining subelytral air has also been mixed with atmospheric air and thus rendered respirable. To perform the above respiration procedure, the

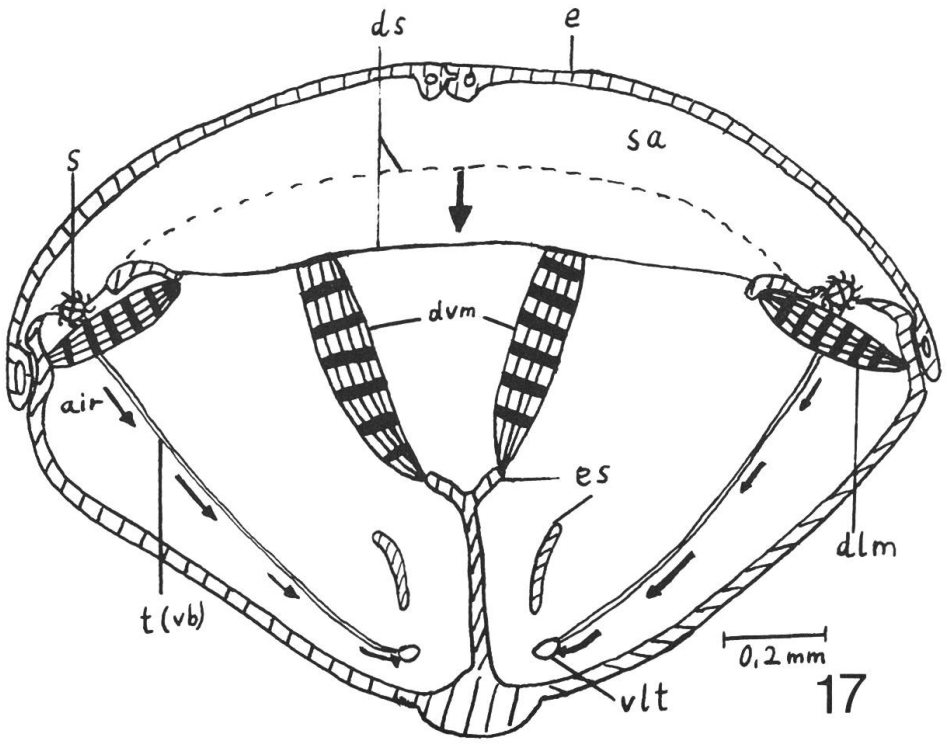


Fig. 17: *H. palustris (L.),* first expiration phase (cross-section), contraction of the dorsoventral (dvm) and dorsolateral muscular system (dlm), ds = abdominal tergite(s), e = elytron, es = endoskeleton, s = spiracle, sa = subelytral area, t(vb) = trachea (ventral branch), vlt = ventral longitudinal trunk, ⊗ = closed spiracle (54 ×).

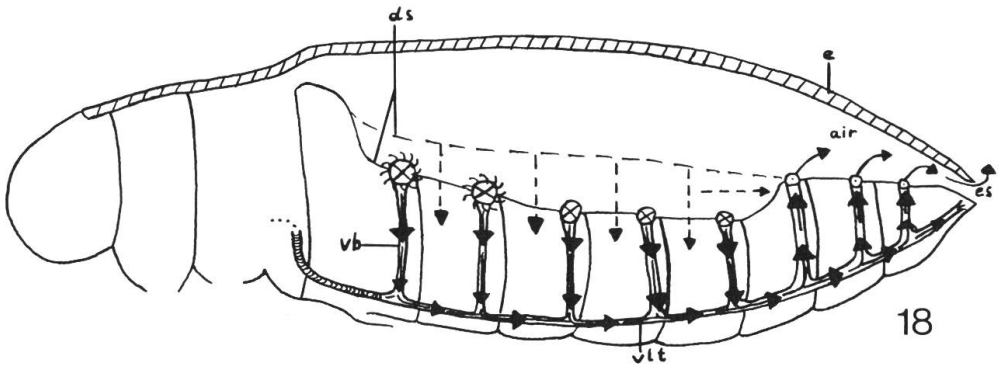


Fig. 18: *H. palustris (L.),* first expiration phase (longitudinal section), ds = abdominal tergite(s), e = elytron, es = expiration slot, vb = ventral branch, vlt = ventral longitudinal trunk, ⊗ = closed spiracle, ⊙ = open spiracle (44,8 ×).

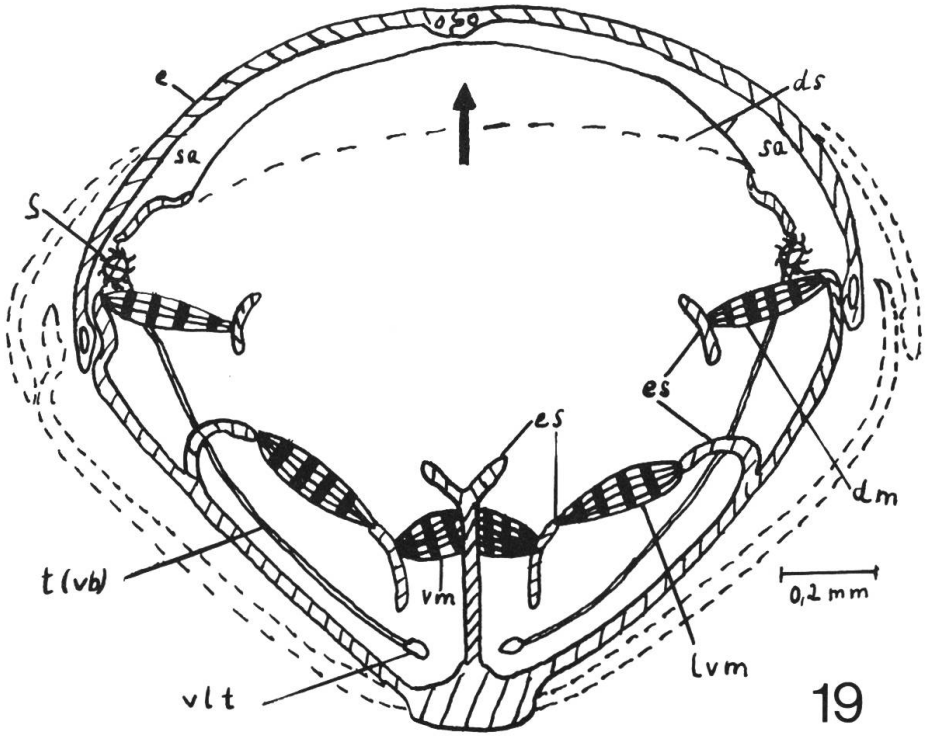


Fig. 19: *H. palustris (L.),* second expiration phase (cross-section), contraction of the dorsal (dm), lateral-ventral (lvm) and ventral muscular system (vm), ds = abdominal tergite(s), e = elytron, es = endoskeleton, s = spiracle, sa = subelytral area, t(vb) = trachea (ventral branch), vlt = ventral longitudinal trunk, ⊗ = closed spiracle (54 ×).

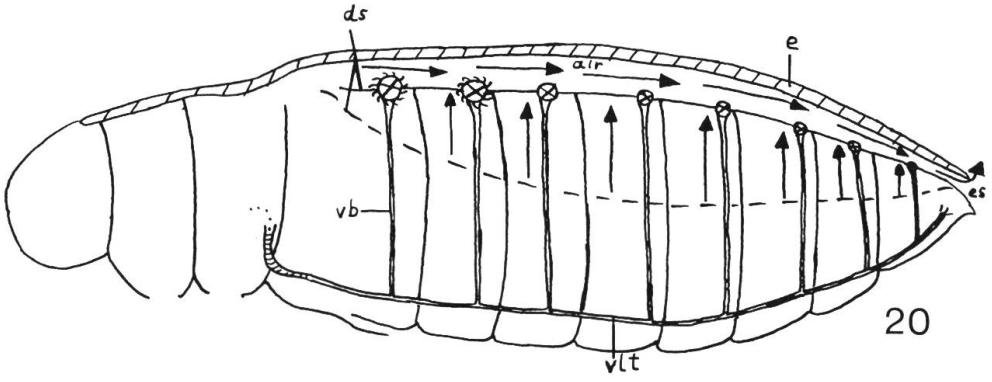


Fig. 20: *H. palustris (L.),* second expiration phase (longitudinal section), ds = abdominal tergite(s), e = elytron, es = expiration slot, vb = ventral branch, vlt = ventral longitudinal trunk, ⊗ = closed spiracle (44,8 ×).

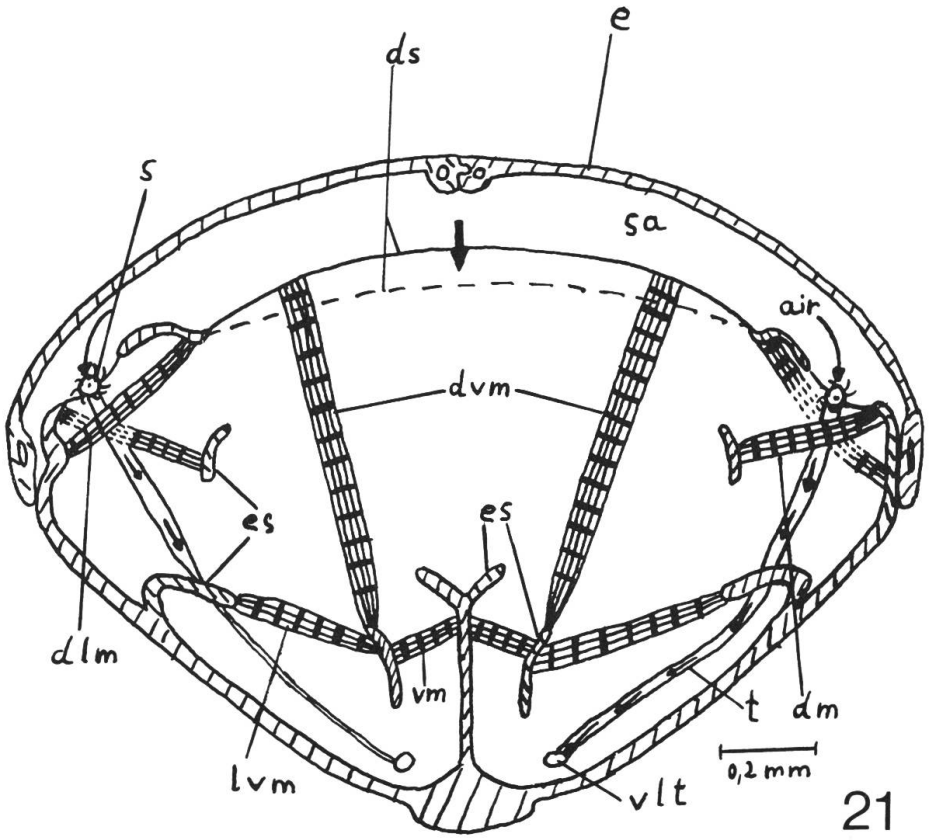


Fig. 21: *H. palustris (L.),* inspiration phase (cross-section), relaxation of the muscular systems, dlm = dorsolateral muscular system, dm = dorsal muscular system, ds = abdominal tergite(s), dvm = dorsoventral muscles, e = elytron, es = endoskeleton, lvm = lateral-ventral muscular system, s = spiracle, sa = subelytral area, t = trachea, vlt = ventral longitudinal trunk, vm = ventral muscular system, ⊙ = open spiracle (54 ×).

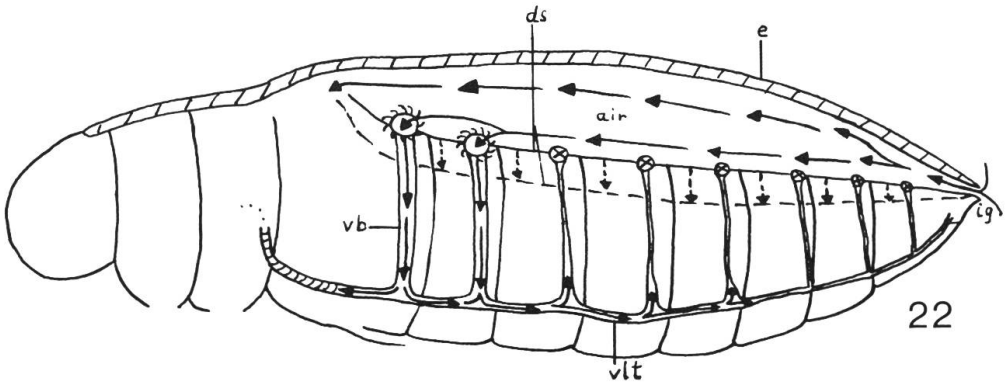


Fig. 22: *H. palustris (L.),* inspiration phase (longitudinal section), ds = abdominal tergite(s), e = elytron, ig = inspiration gap, vb = ventral branch, vlt = ventral longitudinal trunk, ⊗ = closed spiracle, ⊙ = open spiracle (44,8 ×).

beetle remains on the water surface (Fig. 14) for a period of approximately 5 to 10 seconds, following which its presses its pygidium against the elytra and thus leaves the surface of the water, without loosing any air bubbles. Having reached the bottom, it anchors itself on plants or other objects with its front and middle legs. Respiration underneath the water surface is now performed by normal diffusion processes through all spiracles (Fig. 3), which are entirely sufficient for a small beetle like *H. palustris (L.)* The thoracic area, and also the head, are fed in this way through the ventral longitudinal trunks and the thoracic spiracles themselves.

The danger of dust particles entering through these spiracles, which do not have a dust filtering system, is very low, since they are used only for diffuse inspiration. Dust particles transported during this inspiration process are very small, so that they would not be retained by a dust filtering mechanism in any case. On the other hand, they cannot cause any harm to the tracheal system.

After the beetle has been under water for a few minutes, it finally squeezes out a small air bubble from the tip of its abdomen (Fig. 1), which it uses as a physical gill. This additional oxygen reservoir, e.g. during summer, enables the beetle to remain under water for a period of 20 to 30 minutes on an average.

Tests I have made (Experiment 1, 2) have shown that, due to the effect of the physical gill, the beetle can draw a maximum of about 12 times more oxygen from the subelytral air than it brought from the water surface. WIGGLESWORTH (1959) specifies a value of 13 times for water insects. The average oxygen absorption of a beetle *(H. palustris (L.))* through the air bubble is 0.04 to 0.05 mg $O_2$/h, at 18° C and in case of oxygen saturation. This was measured in the undermentioned test setup (Fig. 23; see description in part "Method").

**Experiment 1:**
Conditions: 20° C, oxygen saturation

In this experiment a beetle was involuntarily kept under the water surface by means of a glass dish turned upside down under the water surface. Its behaviour, particularly its respiratory pattern and hydrostatic behaviour, was observed in this extreme situation.

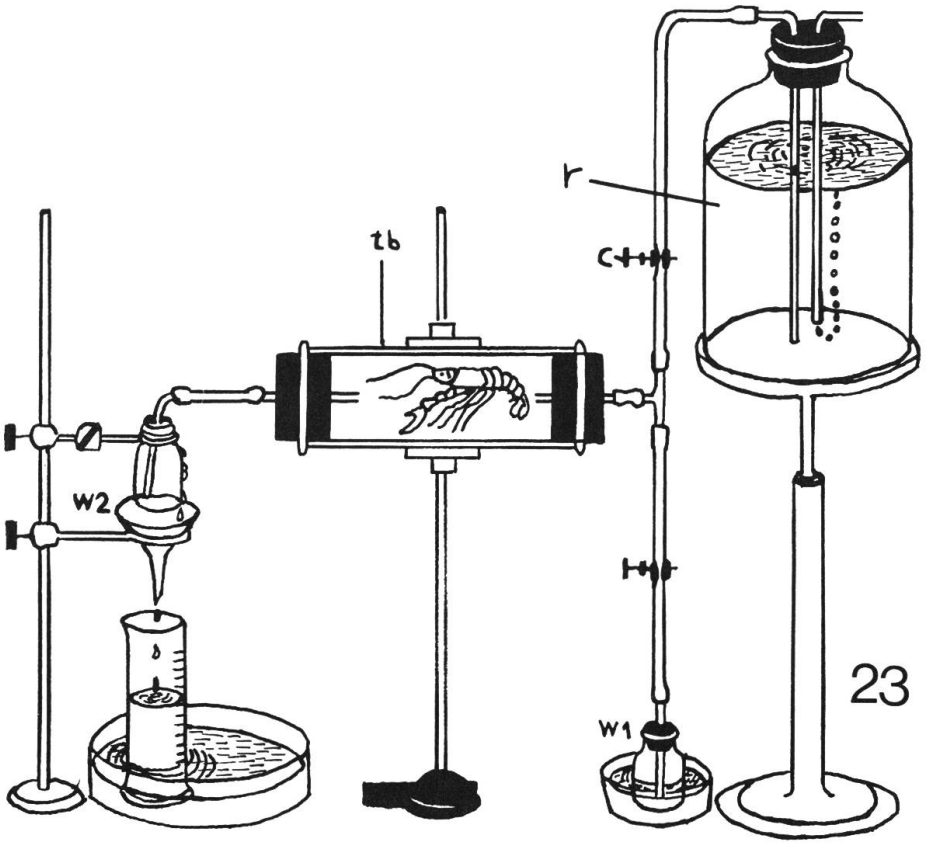


Fig. 23: Test setup for measuring the oxygen content in the breathing water of a crayfish by the method of Winkler (by Nachtigall), after EMMERICH (1980): Stoffwechselphysiologisches Praktikum, Georg Thieme Verlag Stuttgart • New York. This test setup "en miniature" was used for measuring the oxygen absorption of *H. palustris (L.)*, c = clip, r = reservoir, tb = test basin, W1, W2 = Winkler bottles.

**Experiment 2:**

Conditions as above.

In the second experiment a lump of plasticine was attached to the end of the beetle's abdomen, and the beetle was prevented from coming to the surface as well as from using the physical gill. During the test the beetle was prodded with a small stick at intervals of 30 seconds. Its reaction showed whether the beetle was still active.

**Results**

In the first experiment, the beetle managed to remain under water for an average of three hours. At te end of this period, it was suffering from a severe shortage of oxygen and tried with all its might to extend its pygidium, in order to bring a thin air film in contact with the water. At this stage, I released the beetle.

In the second experiment, the beetle lost conciousness after an average of aproximately 15 minutes and showed no reaction whatsoever. It was then released and emerged from torpor on the water surface.

## Discussion

The most problematic part of this paper is the description of the respiratory technique. It is very difficult in this area to furnish convincing evidence or conduct illustrative experiments, particularly where such a small beetle is concerned. However, WESENBERG-LUND (1912) and HEBERDEY (1938) already tackled these questions. But, WESENBERG-LUND (1912) and HEBERDEY (1938) unfortunately do not refer to the entire structure of the tracheal system of the Dytiscidae in their publications, although, in my opinion, accurate knowledge of this system is essential if a respiration model is to developed.

Therefore, extension of research in this field would certainly bring about numerous new results. Accurate investigations of the tracheal systems of the various genera of the Dytiscidae are therefore highly desirable.

Due to the small size of *H. palustris (L.)* (3.5 mm), this paper cannot provide the same degree of detail as the paper of ALT (1912). Nevertheless, the method used enabled it to reconstruct the respiratory system of *H. palustris (L.)*, concerning its important features. I therefore hope that the following paper will be regarded as an incentive for further and more detailed research in this field of the Dytiscidae.

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