THE ENERGY COST OF STANDING IN HORSES[1]

THAT basal metabolism of the horse may be determined while the animal is standing is suggested by the fact that it appears to rest as comfortably standing as lying, and actually spends more sleeping time in the former than in the latter position. Resting metabolism data have been obtained on two pony mares trained from infancy to lie at command, and to tolerate a metabolism mask connected to a large spirometer of the Benedict-Collins type. While the difference is insignificant, metabolism of lying animals was found to exceed that of the horses in the standing position, as shown in Table I.

TABLE I

METABOLISM OF HORSES IN STANDING AND LYING POSITIONS

	Three year old filly Weight 700 lbs. (19 trials in each position)		Four year old lactating mare Weight 800 lbs. (9 trials in each position)	
	Standing	Lying	Standing	Lying
O_2 consumption, Cal/hr.	403.9 ± 19.8	432.3 ± 12.0	406.6 ± 40.2	448.3 ± 23.3
Ventilation rate, Liters/minute	86.8 ± 5.3	114.5 ± 2.9	69.9 ± 9.4	107.3 ± 3.7
Respiration rate, Resp./minute	13.3 ± 0.4	20.9 ± 0.5	11.6 ± 0.9	20.8 ± 1.1

The significant increases in ventilation and respiration rates observed in the lying position suggest that lying may interfere in some way with ease of respiration, and this in turn may increase metabolism. This, combined with the effect of the powerful suspensory and check ligaments which are doubtless an important factor in decreasing the energy cost of standing in horses, may explain the observation that metabolism of the horse is no higher, and indeed may be lower, in the standing than in the lying position. On the other hand, cattle and sheep, species which lack these powerful ligaments, exhibit an energy cost of standing of 10 per cent.[2]

The mares, on lying, usually assumed the characteristic position on one side of the chest in preference to that on the side with legs extended. Oxygen consumption ordinarily was determined once with the animal in the standing position, and once in a lying position on a given day. On some occasions the first determination was made with the animal in the standing position, while on other days this order was reversed. Lying down appeared to have no significant effect on pulse rate of the animals.

Since oxygen consumption of horses is no greater when the animals stand than when they lie, the latter position offers no advantage over the former in the measurement of basal metabolism.

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SCIENTIFIC APPARATUS AND LABORATORY METHODS

SIMPLIFIED PHOTOMICROGRAPHY WITH A HAND CAMERA

THE relative ease with which good photomicrographs can be made, utilizing a box or folding hand camera and roll film, has not been generally recognized by visual microscopists, nor have the increased opportunities for making such photographs which are provided thereby because no darkrooms are required.

Most of the articles which have been published on simplified photomicrography recommend removal of the camera lens. The method described here consists in first independently focusing the microscope visually and then placing above (or behind) the ocular a roll-film or film-pack camera which has been focused at infinity or at another predetermined distance. Almost any type of personal camera can be used efficiently without mutilation and with the camera available immediately for other use. That the camera can be loaded in daylight and the films sent to the nearest drugstore for development and printing may be the chief advantages of the method to microscopists with no photographic facilities or experience.

The optical efficiency of this method is high if used properly; the definition of the pictures will be equal to that obtained with professional procedure and equipment. The optical considerations involved and the basis of the specific procedure that should be followed to obtain satisfactory results will be discussed more completely in a forthcoming article in a photographic journal. The Ramsden disk or eyepoint of the microscope should lie on the middle of the front surface of the camera lens ("vertex focus"), in which case the effective aperture of this lens is extremely small and the common optical aberrations become

[1] Journal Series number 849.

[2] Warren C. Hall and Samuel Brody, *University of Missouri Agricultural Research Bulletin* 180, 1933.

negligible. A simple one-element lens such as those of inexpensive cameras is actually preferable in this case. As the camera lens is withdrawn from the eyepoint so that an appreciable lens aperture is used, chromatic aberrations are the first to have influence, but are practically eliminated if a color filter is used. The image degradation increases more rapidly as the camera lens is lowered below the eyepoint, however, than when it is raised.

Focusing the Camera

Since most people accommodate somewhat in focusing a microscope it is preferable to set the camera focus at twenty-five feet rather than at infinity and a fixed-focus camera is quite satisfactory. With a focusable camera it is preferable to determine the correct distance setting for the individual by making a series of negatives. Some individuals place the images as close as ten feet, but the distance may be variable, especially with young people.

By far the best procedure is the use of a telescope with a cross hair or other graticule in its eyepiece which has been carefully set for the individual focus. The focus of the entire telescope can then be set for the distance setting of the camera, such as infinity, by focusing out of the window. If the microscope image is focused through the telescope, even though this over-magnified image seems very poor, every worker may obtain identically excellent photomicrographs. If used by only one person a crude and simple telescope will be satisfactory if it will stay in adjustment, since it need be focused only once. A very satisfactory instrument was made by holding a 48-mm microscope objective by a cork in a metal tube so that the normal front of the objective faced the other end of the tube. A homemade graticule was held in the tube by another cork and this was viewed by a magnifier from a dissecting stand at the other end of the tube. If a micrometer microscope ocular is used, the lower lens should be screwed out.

Magnification

Since the camera lens determines the bellows length, with a hand camera the magnification obtained in the picture is always a fraction of the apparent (or catalogue) magnification; with a Kodak 620, for instance, the magnification is one third of the objective × ocular value. The effect is to reduce the magnification of the ocular. Therefore, only high-power oculars are satisfactory for photomicrography with a hand camera, oculars of 25× or more being most suitable.

Disadvantages

Since the definition of the photomicrographic image properly taken with a hand camera is equal to that taken by more expensive and elaborate outfits, and the procedure is simple, there must be disadvantages that have prevented its widespread adoption. There are only three important ones.

(1) The camera lens must be scrupulously clean, since any dust or marks on the lens will appear on the negatives, enlarged and slightly out of focus. (2) When the lens is at the eyepoint the whole visual field of the microscope is taken so that the picture is surrounded by a ring of out-of-focus detail, whereas in photomicrography on a large bench only the central portion of the field is taken. Raising the camera restricts the field, but a slight loss in general definition also occurs. (3) The ease with which a flare spot is produced in the picture is the greatest disadvantage of this method. In some cases it is unavoidable. The bright back lens of the objective may be imaged on the negative as a spot of increased density. With most of the cameras tested the flare image was in best focus at the same camera height that gave best image definition, *i.e.*, with the vertex focus at the eyepoint. As the camera is raised, the flare spot goes out of focus fairly rapidly, but some definition is lost.

Where critical definition is not required the camera can be raised considerably above the eyepoint to control the last two defects.

Apparatus

For this method the camera must be supported independently of the microscope and have no contact with it. When a record is unexpectedly needed the microscope should be tilted horizontally and the camera blocked up behind it at the required distance and along the same axis.

A stable, convenient apparatus can be set up from regular laboratory equipment with relatively little labor and at small cost. The ordinary ⅜- or ½-inch laboratory support rod is not sufficiently sturdy. A commercially obtained 19-mm vertical support rod and base plate can, however, be used. The right-angle clamp should fit this rod with a round hole rather than a V groove. The whole device is illustrated in Figs. 1 and 2. The base plate can, of course, be screwed directly to a bench or table top. Three small pieces of felt or adhesive tape are stuck underneath the corners of this board to act as feet.

The camera support (D or E of Fig. 2) consists of a wooden block stapled to the top of a 7-inch laboratory extension ring support. For folding cameras a rectangular hole, having the same dimensions as the folding flap of the camera front, is cut in the center of the board. The camera can easily and quickly be pushed into the same position each time, using one end of the hole and a strip of wood at one side as guides. The face of the board and the side of the strip should be covered with cloth to protect the camera. Two right-angle hooks are placed opposite each other at each end of the camera. The camera is fastened down firmly by slipping two wide elastic bands over the hooks. It can thus be removed for other use or replaced in a few seconds.

To support non-folding cameras, holes are drilled into the board to provide for protuberances on the face of the camera (support *D* of Fig. 2 was made for a Brownie).

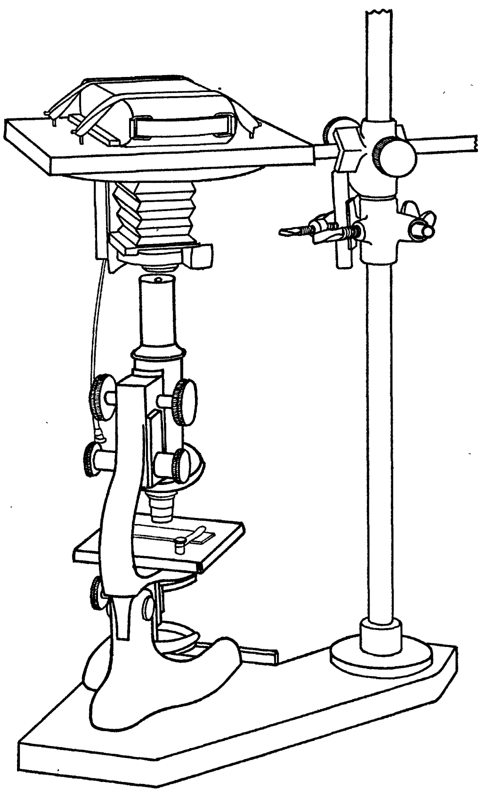

FIG. 1

By placing another clamp below the right-angle clamp that supports the camera ring, the camera can be swung out of the way when not in use. Moreover, by placing a short vertical rod (Fig. 2 C) as shown in Fig. 1, the camera is instantly realigned when its supporting clamp hits the vertical rod.

EXPOSURE CONTROL

The camera shutter is imaged on the field especially if the camera lens is slightly raised above the eyepoint, and this will vignette at very short exposure times to give apparent uneven field illumination. It is perfectly satisfactory when used with a watch on time exposures. A simple but satisfactory procedure for black-and-white pictures is to use a "blinker connection" such as is sold for Christmas-tree lights and to count the number of flashes to determine the exposure time.

DIRECTIONS

After the apparatus is set up and it is desired to photograph some specimen under the microscope, the procedure is as follows:

Determine the eyepoint of the microscope (illuminated disk of minimum diameter) with a piece of white paper.

Focus the camera at 25 feet or other predetermined distance.

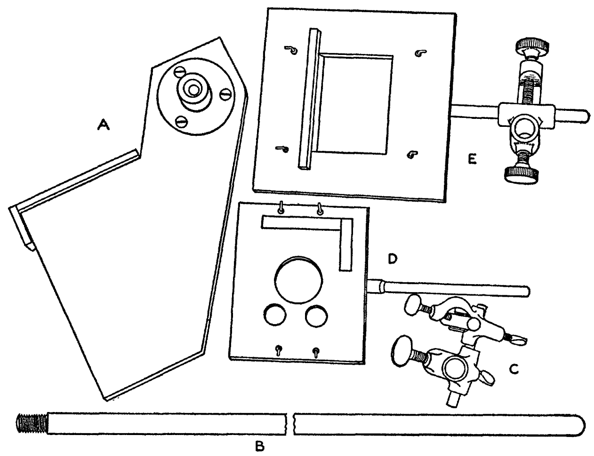

FIG. 2.

Lower the camera to make the front surface of the lens coincide with this point or be slightly above it.

Bring the lower clamp up to the other one and clamp it.

Loosening the upper clamp, align the camera lens with the ocular. This is best done the first time through the open back of the camera (containing no film) by looking through the lens. Tighten the upper clamp.

Rotate the lower clamp until the short vertical rod hits the upper clamp and again tighten it.

The camera can then be swung aside and a light-tight-connector attached to the lens.

Focus the microscope visually, preferably through a telescope.

Swing back the camera and take the picture.

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BOOKS RECEIVED

DRESCHER, ARTHUR B. and OTHERS. *Studies of Cenozoic Vertebrates of Western North America and of Fossil Primates (Contributions to Paleontology).* Illustrated. Pp. iii + 222. Carnegie Institution of Washington. Paper cover, $2.25; cloth binding, $2.75.

LLOYD, FRANCIS ERNEST. *The Carnivorous Plants.* Illustrated. Pp. xv + 352. Chronica Botanica, Waltham, Mass.; G. E. Stechert, New York. $6.00.

MAYR, ERNST. *Systematics and the Origin of Species.* Illustrated. Pp. xiv + 334. Columbia University Press. $4.00.

NEEDHAM, JOSEPH. *Biochemistry and Morphogenesis.* Illustrated. Pp. xvi + 785. Macmillan. $12.50.

WELCH, D'ALTÉ E. *Distribution and Variation of the Hawaiian Tree Snail Achatinella Apexfulva Dixon in the Koolau Range, Oahu.* Illustrated. Pp. 236. Smithsonian Institution.