been accomplished by the unique arrangement of a circular false floor that comfortably supports the animal above the wire mesh during the experimental period, and keeps him oriented in such a way that all feces, regardless of the animal's position in the unit, pass through the circular openings and are collected below on the removable mesh floor. The false floor separator, as described, can also be used satisfactorily in the ordinary commercial dog cage where balance studies are desired.

The metabolism unit illustrated in Fig. 1 is inexpensive and of simple design, with removable parts that may be easily cleaned or conveniently discarded if and when contaminated with radioactivity. The restraining walls are constructed from a 24″ width of corrugated metal[2] mesh rolled to form a round cage 29″ in diameter; the edges are held in position by four 1¼″ bolts. Two openings are made in the front of the cage to allow the dog free access to feed and water from commercial dog feed cups suspended outside the walls. These openings are made by cutting the side and bottom of an area 6″ × 6″ and pulling the attached wire outward over the containers, which prevents the animal from attempting escape. The openings are protected by sewing a strip of heavy canvas around the raw edges of the metal. Four L-shaped metal straps attached to the outside walls fit over a sturdy fitted frame made from 2″ × 4″ boards supporting the cage at a convenient height above the floor.

The novel feature of this unit is the false circular floor separator on which the animal stands during the experimental period (Fig. 2). It is constructed from two or more concentric 3″ widths of ½″ plywood, sawed and fitted in a circular pattern 3″ apart to form a removable circular floor 24″ in diameter. The plywood is secured to three ¼″ iron rods that protrude outward to hook on the inside of the cage. One of these supporting rods may be retracted to permit ready removal of the floor from the cage. A 7″ opening in the center of the floor permits the insertion of a 6″ roll of ½″ mesh hardware cloth (Fig. 1 *C*) that rests on the removable corrugated metal floor below (Fig. 1 *B*) and extends the entire height of the cage. This arrangement serves to restrain the animal without discomfort in such a position that the feces always pass between the plywood boards onto the metal screen below. The urine, most of which is voided by the male directly onto the hardware cloth cylinder in the center of the cage, passes through the mesh floor onto a 32″ × 32″ galvanized metal funnel (Fig. 1 *A*), which diverts it into a carboy below. To minimize splattering and the spread of radioactivity, especially with females, a removable metal liner 17″ high is inserted inside the cage and fitted under the feeder against the sides of the wire mesh walls. The cage cover is constructed from conveniently spaced 1″ × 2″ wooden strips and is attached to the top of the cage at the back with an 8″ metal T-hinge; it is secured at the front by a heavy wire hook.

[2] No. 9-11 gauge flattened mesh is available in 4′ × 8′ sheets from Wheeling Corrugating Company, Wheeling, W. Va.

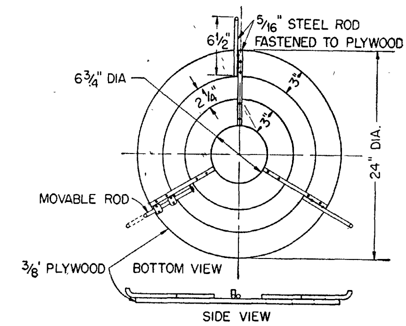

FIG. 2. Schematic diagram of the circular false floor separator for use in dog metabolism cages.

To facilitate cleaning and decontamination, the metal liner, false floor separator, and urine funnel are sprayed with a strippable paint[3] previous to use.

This metabolism unit has wide application in studies involving not only radioisotopes, but whenever it is desirable to make quantitative separate urine and fecal collections with 7–12 kg dogs of either sex. The simplicity and economy of construction and the restraint accomplished without undue restriction of the animal's movements during the experimental period make the unit especially useful for metabolism studies with radioisotopes.

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[3] A strippable paint called "Cocoon" is available from Hollingshead Corp., Camden, N. J.

Fall in Minimum Night Temperature at or near Full Moon: Part II

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The atmospheric temperature fluctuations on the earth's surface have been carefully recorded for many years by numerous observers, whose investigations have elucidated most of the causes of these fluctuations. Such explanations have been founded on well-established meteorological and other phenomena, caused chiefly by the heat and light of the sun; but little attention seems to have been paid to its gravitational action, and also that of the moon, on the earth's atmosphere. The effects of the gravitational pull of both these bodies on the shape of the earth and on its tides in the waters of the seas are, of course, well established, though the exact amount of the pull, ascribed to either the sun or moon in causing any given tide, appears not to have been calculated with precision (*1*), owing to the continuous motion of the sun, moon, and earth.[1]

The forces of the gravitational pull of both sun and moon on the sea, in causing the tides, pass through the earth's atmosphere before reaching the surface of the sea, but it cannot be supposed that these forces exert no action on the atmosphere. Such forces could not by-pass the atmosphere without affecting it, and such an effect would be to cause atmospheric tides, analogous to the water tides below them, but not identical with the latter in their modes of formation, times of occurrence, or physical results. The height of the tides is augmented by ocean currents, by winds, and by the configurations of the coasts; those of the atmosphere will be similarly modified by prevailing winds, by sudden cyclonic storms, or by the rise of large volumes of heated air from land surfaces; but there are no coasts to interfere with the atmospheric tidal waves, excepting, perhaps to a small extent, very high mountain ranges. Consequently the atmospheric tidal wave will, in the absence of such modifying influences, pass more or less smoothly around the earth, under the gravitational pull of the moon, without the time lag of the water tides, where the greater specific gravity of the water (about 815 times that of air at sea level), the horizontal component, and other forces operate; nevertheless, such an atmospheric tidal wave will be greatly modified at times by meteorological conditions, as well as by the positions of the sun and moon.

In a previous communication (*2*) it was demonstrated that the fall of minimum temperature near full moon was less in summer than in winter; and it is a well-known fact that the tides of the sea are lower at the summer than at the winter solstice. Since the fall of minimum temperature is a gauge of the height of the atmospheric tide, the two phenomena are in agreement with each other and must be caused by the same force.

There is a fundamental difference between the action of such a force as the moon's gravitational pull upon a solid or a liquid, on the one hand, and that upon a gas, on the other—at least near the earth's surface. In considering a cubic centimeter of earth under tidal action, it is raised *in toto,* without expansion or alteration of temperature, through a centimeter or two, and, after the tide has passed, it falls back and remains as it was originally. The same type of action occurs, under analogous conditions, in the tides of the sea; the cubic centimeter of water is raised through 10–16 cm in the Mediterranean Sea, where no disturbing factors normally arise; there is little or no alteration in its volume or temperature, and the cube of water falls back unchanged. The cubic centimeter of air, however, is not lifted up *en bloc*; it is merely expanded upwards by a slight reduction of pressure upon it; i.e., g of earth $- g$ of moon's pull, the amount of this expansion causing a wave in the upper atmosphere, traveling under the moon and dependent upon various factors.

To expand a gas it must undergo either an absorption of heat under constant pressure, or a reduction of pressure under constant temperature; and since the atmosphere receives no external heat during the night, its expansion must be due only to reduction of pressure caused both by the gravitational pull of the moon when it is in or near the zenith, or by that of the sun in the nadir. But to expand a gas solely by pressure reduction necessitates an adiabatic expansion with fall of temperature, since no external work is done—i.e., the Joule-Thomson effect. The atmosphere under the full moon, therefore, is adiabatically expanded, the temperature falls and is registered by the thermometer; hence the fall of minimum night temperature near full moon (*2*).

There are many factors that modify this phenomenon, the chief ones being (*a*) the temperature, which is soon raised again, first by reabsorption of heat from the surrounding air and from the ground below, but not before the lowered temperature has had time to influence the thermometer, and, second, by a partial contraction in the initial wave owing to loss of heat on expansion; (*b*) the latitude of the place in which the temperature fall occurs; the value of g of the earth being slightly less and that of the moon slightly greater in low latitudes (also the air is heavier with aqueous vapor); (*c*) altitude: as this increases the aqueous vapor content of the air decreases; (*d*) meteorological conditions, such as winds, cloud, rain or snow, warm air uplift, etc.

Air in tropical regions is at a fairly high temperature even at night and is normally considerably more expanded than air in higher latitudes, as well as being more loaded with aqueous vapor; consequently, the further expansion of such warm air will not be as great under the gravitational pull of the moon as would be the case with drier air at much lower temperatures; hence adiabatic expansion will be less in volume, causing the minimum temperature fall to be less near the equator, although the pull of the moon is somewhat greater and that of the earth less.

If adiabatic expansion is the correct explanation, then there should be a fall of atmospheric pressure more or less concurrent with the fall of temperature. The sudden reduction of pressure will be greater and probably more apparent at higher altitudes. Such diminution of pressure, though only to a small extent, has been noticed in the records of two stations, both near sea level and as far apart as possible in both distance and time. Table 1 gives the minimum temperature fall, with the dates between which it occurs, and also the recorded fall of pressure with its dated periods; the two columns of dates show them to be almost synchronous and close to full moon dates.

The view that any fall of temperature near full moon is caused by absence of cloud, thus permitting the cold of higher altitudes to penetrate the lower atmosphere, is not based on exact facts. True, there

[1] If such calculations have since been carried out, the author is unaware of them.

are often cloudless nights around these dates, but by no means always. In North Wales, during the years 1948–51, there were observed 27 lunations, out of which 18 were cloudy on nights covering the falls of minimum temperature; in 8 of these there was rain all night; in 9, gales, and in 1, snow. Again, the station at Dehra Dun, India, sent records of the years 1948–50, in which 33 lunations were noted; of the nights of minimum temperature fall, 20 were cloudy and 2 were rainy: at neither station did the temperature fall fail to take place.

cm; and by calculation, in which the minimum temperature fall is used as a gauge of the expansion, then from the gas equation

$$\frac{V}{T} = \frac{V_1}{T_1},$$

where $V = 820$ ml; $T = 288°$ abs, $T_1 = 293°$ abs, then $V_1 = 834$ ml. On subtraction $834 - 820 = 14$ ml expansion, which is close to the 13 cm given above.

If the volume 820 ml stands on unit area, 1 cm^2, then it will be in the form of a square column (Säule)

TABLE 1

Month	Wellington, New Zealand, 1939 (Alt, 415 ft (126 m) 41° 16′ Lat S)					Caerwys, North Wales, 1949 (Alt, 600 ft (183 m) 53° 15′ Lat N)				
	Full moon dates	Barometric fall mm Hg	Between dates	Min temp fall F°	Between dates	Full moon dates	Barometric fall mm Hg	Between dates	Min temp fall °F	Between dates
Jan.	5	6	2– 7	3	5– 6	—	—	—	—	—
Feb.	4	7	2– 6	6	2– 3	—	—	—	—	—
Mar.	5	5	1– 8	2	5– 6	14	5	12–14	6	12–14
Apr.	4	3	2– 3	19	3– 5	13	20	9–12	3	12–14
May	3	18	2– 7	14	4– 5	12	17	12–14	9	9–11
June	3	5	4– 5	10	May 30–June 3	10	6	5– 7	16	7– 9
July 1	1	22	June 29–July 3	8	2– 3	9	3	8– 9	9	7– 8
" 2	31	7	27–29	2	30–31	—	—	—	—	—
Aug.	29	16	28–30	10	27–28	8	6	7– 8	5	5– 8
Sept.	28	3	27–29	7	27–28	7	4	4– 5	13	4– 7
Oct.	28	9	28–30	11	26–27	6	11	4– 9	7	3– 5
Nov.	26	2	25–26	11	23–25	5	30	1– 6	11	5– 6
Dec.	26	12	20–27	13	25–27	5	5	4– 6	9	1– 5

The expansion that is due to the gravitational pull of sun and moon on the atmosphere may be visualized by considering an ideal case. Taking the conditions prevalent at Perth, W. Australia, during the year 1950, a station situated at sea level and in 30° 0′ Lat S, where the average minimum temperature fall near full moon was 5° C and the temperature just before the fall was 15° C = 288° abs, the volume of 1 g air at N.T.P. = 777 ml corrected to 15° C = 820 ml; this, then, is the volume of 1 g air at the temperature of the station, and this will be expanded under the gravitational pull of the moon. Although the strength of this pull is accurately known from Newton's law of gravitation, its exact value in causing a tide is unknown (*1*). It is, therefore, necessary to estimate the amount of expansion by indirect means—by analogy with the tide in the Mediterranean Sea, where there are few disturbing influences, which raises a unit mass of water, 1 g through 10–16 cm, as a mean, say, 13

820 cm high, which will be expanded upwards 13–1.6% to 833 cm. At 20,000 ft/(610,000 cm) altitude, at least half the ponderable atmosphere will be included. On extending the ideal column 820 cm to this height, there are 744 such columns, one above the other, and there will consequently be that number of 13 cm expansions, or a total of 9672 cm (317 ft).

Similar, though less strong, tidal waves will occur daily during all phases of the moon, exactly as with sea tides; nevertheless, they may be greatly altered by local meteorological conditions. They may give rise to snowstorms in high latitudes and also may be the cause of some of the "air pockets of low pressure" encountered by airmen.

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