KEY TO THE SPECIES MENTIONED IN THE PRECEDING PAPER.

The general neglect of our crustacea by the students of our local natural history, if not a discredit, is at least a misfortune; for no other class of animals accessible to the inland student will repay study so promptly and so generously; since while the species are comparatively very few, they present many and extreme diversities of form and structure. The differences between the *orders* of this class,—between the *families*, even, of some of the orders,—are more profound, penetrate farther into the interior of the animal, affecting structures commonly far more stable, than do the differences between the other *classes* of the sub-kingdom. In the same order hearts may be present or absent, in the same tribe gills may be filamentous or lamellate, in the same genus so complex an organ as the eye may be well-developed or entirely wanting; and everywhere not external form alone seems plastic, but internal structure also. Indeed, this is but an instance of a more general truth. In every well founded sub-kingdom the lowest class stands nearest the point of common origin,—illustrates, therefore, most closely by its diversities the first divergencies of the group from which the later groups have sprung In this primeval group structure must have been much more unstable than in the later higher ones, else the stable structural characters which now distinguish classes could never have arisen; and in the lowest present class, which has departed least from the condition of this primeval group, this instability of structure may be expected to persist,—structural differences will have less "value" for purposes of classification.* Hence in the study of the few examples of this lowest class of arthropods, we rapidly acquire a more fruitful knowledge of nature's multiform adjustments, encounter more numerous and suggestive illustrations of her general laws, than by much longer and more elaborate study of the higher groups. For the amateur and the beginner the crustacea have further a peculiar interest from the fact that the transparency of some of the smaller forms makes possible the direct and easy study of the entire living organism. Nothing better could be devised for the luminous demonstration of the leading facts of animal physiology. In a single colorless *Asellus* or *Crangonyx* may be observed at leisure, under a low power of the microscope, the respiratory movement, the circulation of the blood, the motions of the heart and the actions of its valves, the contraction and relaxation of muscular fiber, the processes of digestion, as well as the general and minute anatomy of the entire animal.

The economical interest of the subject should not be overlooked. With the progressive settlement of the country we must look forward to a continuous advance in the price of animal food, and with this advance the question of our inland fisheries will rise yearly into higher prominence. But intelligent measures for the increase and preservation of our edible fishes

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*This principle, that *structural characters diminish in importance downward*, has been ignored, I think, by some of our recent ichthyologists.

presuppose an acquaintance with the natural history of our crustacea, which are as essential to fishes as insects are to birds.

With a view to removing some of the many difficulties which have prevented a more general study of this captivating and important class, I add to the foregoing paper the following simple synopsis of the species mentioned, which it is hoped that any intelligent student may use successfully. It is of course a mere compilation designed as a temporary aidto local students. A few species from Lake Michigan have been included which have not yet been found within the limits of the state, but which must nevertheless occur there at least occasionally.

CLASS CRUSTACEA.

Arthropoda usually with jointed abdominal appendages and two pairs of antennae. All save a few minute forms with more than four pairs of legs. Respiration by distinct gills, by gill-feet, or by the general surface of the body.

ORDER DECAPODA.

Head and thorax consolidated, forming a cephalo-thorax ; eyes compound, on flexible stalks.

FAMILY ASTACIDAE.

Abdomen depressed, carapace (1) with a transverse channel, edge united with the epistoma (2) ; gills very numerous, composed of filaments ; the three front pairs of feet chelate (3), the first much the largest.

Genus Cambarus.

The fifth pair of legs without gills ; last segment of thorax movable. Rostrum (4) simple or with one tooth on each side. First abdominal legs of male (5) more less divided.

a

Oblique tubercle on front margin of third joint of third and fourth pairs of legs of male.

C. acutus, Girard. Areola (6) much wider behind than before. Thorax densely tuberculate on sides, nearly smooth above. Movable finger much longer than inner side of hand.

C. troglodytes, Leconte. Areola narrower behind than before. Thorax granulate on sides, strongly punctate above. Movable claw not longer than hand.

aa

Oblique tubercle on third joint of third pair of legs of male, none on fourth pair.

b

First abdominal legs of male not distinctly bifid.

C. gracilis, Bundy. Rostrum broad, short, toothless ; finger not hairy ; first abdominal leg toothed but not recurved at tip.

C. stygius, Bundy. Rostrum long, triangular, with small apical teeth; outer margin of finger hairy; first abdominal legs recurved at tip and three-toothed.

bb

First abdominal legs of male distinctly bifid.

c

C. obesus, Hagen. First abdominal legs short, thick, branches stout, tips recurved, obtuse. Areola linear.

cc

First abdominal legs of male with branches usually long and slender.

d

C. immunis, Hagen. Both branches gradually, strongly and equally recurved. Rostrum short and conical.

dd

Branches not strongly and equally recurved.

e

C. propinquus, Girard. Rostrum carinated (7) on middle of anterior half.

ee

Rostrum not carinated.

C. placidus, Hagen. Rostrum excavated, margins thickened; maxillipeds not hairy beneath; greatest width of hand contained about three times in length of outer margin, inner edge of outer finger not bearded, forearm without two rows of distinct spines beneath.

C. virilis, Hagen. Rostrum sub-excavated, margins thickened, hardly converging; antennal plates not longer than rostrum; maxillipeds bearded without, beneath and within; greatest width of hand about two and one-third times in length of outer margin, outer finger bearded within, forearm with two rows of distinct spines beneath.

C. wisconsinensis, Bundy. Rostrum nearly flat above, narrowed in front; antennal plates longer than rostrum; maxillipeds hairy within and below at base.

FAMILY PALAEMONIDAE.

Abdomen compressed. Carapace without transverse channel, its lower edges free throughout. Gills composed of plates. The third pair of feet never chelate.

Genus Palaemon.

Rostrum long, compressed, serrate; two inner antennae with flagella (8), mandibles (9) with three-jointed palpus (10), first pair of legs slender, second stronger, both chelate.

P. ohonis, Smith Rostrum slightly curved upward at tip, about twelve teeth above and three to five below. Hand of second pair of legs about once and a half the length of the carpus (11).

Genus Palaemonetes.

Differs from *Palaemon* by the absence of mandibular palpi

P. exilipes, Stimpson. Rostrum nearly straight, seven or eight teeth above, one or two below. Hand of second pair of feet about two-thirds as long as carpus.

FAMILY MYSIDAE.

Feet more than five pairs, slender, often bearing palpi, none chelate, usually rudimentary on the abdomen. Gills wanting.

Genus Mysis.

Six pairs of thoracic feet, each with two many-jointed branches; three pairs of maxillipeds (12). Inner antennae with two flagella. Fourth pair of abdominal legs in male very long, styliform, directed backwards.

M. relicta, Loven. Cephalo-thorax about one-third total length, broader behind than before. Pedicel (13) of inner antennae a little longer than the eyes, three-jointed, first joint about as long as second and third together. Inner flagellum shorter and more slender than outer.

ORDER AMPHIPODA.

Body commonly compressed, of fourteen segments; thoracic segments not consolidated, eyes sessile if present. Gill plates thoracic.

FAMILY ORCHESTIDAE.

Upper antennae shorter than lower, no secondary flagellum (14). No palpus to mandible. Epimera (15) large. Last pair of abdominal legs not branched.

Genus Hyalella.

First two pairs of feet sub-chelate (16), the second the larger; upper antennae as long as peduncle of lower; telson (17), short, stout, entire; palpus of maxillipeds five-jointed; first pair of maxillae with very short one-jointed palpi.

H. dentata, Smith. First and second abdominal segments with a prominent tooth on middle of hind margin, second hand of male about three times as broad as first, flagellum of lower antenna commonly but little longer than that of upper.

FAMILY LYSIANASSIDAE.

Body little compressed, first two pairs of feet small and weak, epimera of first four segments very deep.

Genus Pontoporeia.

Upper antennae with short secondary flagellum; first two pairs of legs very short, the first sub-chelate, the second not, seventh pair with basal joint very large.

P. hoyi, Smith. First pair of hands with one to three small slender spines at tip of closed claw. About seven elongated papillae on the second to fifth segments of the sternum (18). Upper antennae short, about as long as head and first three thoracic segments; flagellum about nine-jointed.

P. filicornis, Smith. Upper antennae reaching nearly to tip of abdomen, flagellum of about thirty-three joints, the terminal ones very long and slender. Secondary flagellum of four segments.

FAMILY GAMMARIDAE.

Both antennae well developed, the upper long, slender, filiform, usually immediately above the lower, which are inserted into a notch at the front angle of the head. First and second feet sub-chelate. Eyes compound, commonly between upper and lower antennae.

Genus Gammarus.

No rostrum. Three last abdominal segments each with two or more clusters of short stiff spines on hind margin. Secondary flagellum and mandibular palpus present. Last pair of abdominal legs two branched; telson double.

G. fasciatus, Say. Secondary flagellum as long as second segment of peduncle (19), and composed of five or six segments. Fourth, fifth and sixth abdominal segments each with three clusters of spines on hind margin.

Genus Crangonyx.

No clusters of spines on posterior abdominal segments. Telson single; last pair of abdominal legs with inner branch rudimentary or wanting. Peduncles of the two pairs of antennae sub-equal. The first two pairs of feet sub-equal.

C. gracilis, Smith. Eyes evident. Hind angles of first three abdominal segments each ending in a sharp tooth. Outer branch of last pair of legs about twice as long as peduncle; inner branch very small. Telson short, emarginate.

C. mucronatus, Forbes. No eyes. Hind angles of first three abdominal segments rounded. Outer branch of last pair of legs shorter than peduncle, inner minute. Telson of male a slender spine about as long as first three abdominal segments.

ORDER ISOPODA.

Body commonly depressed; thoracic segments not consolidated; eyes, if present, compound, sessile. Gill plates beneath abdomen. The last four pairs of thoracic legs similar, and differing from the first three pairs. Last pair of abdominal legs more or less styliform.

FAMILY ONISCIDAE.

Abdomen many-jointed, last segment small, caudal stylets (20)well exserted. Mandibles without palpi. Inner antennae obsolete.

FAMILY ASELLIDAE.

Body very flat, loosely jointed. Last abdominal segment very large, shield-like, comprising nearly the whole abdomen. Upper antennae short, lower very long. Only first pair of feet sub-chelate. Mandibles with palpi.

Genus Asellus.

First pair of feet sub-chelate; last thoracic legs not elongate; first pair of abdominal appendages in female (first two pairs in male) small, forming short plates; outer ramus of next pair serving as gill-covers; caudal stylets elongate.

A. brevicauda, Forbes. Head with hind angles laterally extended, forming broad spinous lobes; front angles of first thoracic segment notched, no lateral notches on thoracic segments; tip of abdomen with broad rounded lobe, pedicels of caudal stylets as broad as long, palm of hand with two strong spines.

A. intermedius, Forbes. Head with small lateral lobes. First thoracic segment with front angles entire, others notched laterally; hind angles of abdomen not distinct, pedicel of caudal stylet twice as long as wide.

A. stygius, Packard. Slender, loosely-jointed, colorless and blind; caudal stylets slender, cylindrical, abdomen not lobed behind.

ORDER PHYLLOPODA.

Feet, ten to sixty pairs, broad and flat, two or three-lobed; mouth with mandibles and maxillae, antennae usually small, not used for swimming.

FAMILY BRANCHIPODIDAE.

Body long and slender, no carapace, thoracic segments distinct, eyes on stalks, second antennae converted into clasping organs. Eleven pairs of gill-feet. Female with egg-pouch at base of abdomen.

Genus Eubranchipus.

Head large, claspers (21) of male thick and strong, with a tooth at base of second joint; a pair of simple, flat, serrate, membranous appendages attached to front of head; caudal appendages long, lanceolate, with many feathery hairs. Egg-pouch short, thick, broad-oval.

E. serratus, Forbes. Frontal appendages longer than claspers, irregularly ovate, deeply serrate. Tip of claspers flattened within, abdomen somewhat serrate.

FAMILY ESTHERIADAE.

Compressed; head and body enclosed in a bivalve shell. Eyes sessile; feet, ten to twenty-seven pairs.

Genus Limnetis.

Shell circular, globose, no beaks or lines of growth. Inner antennae two-jointed; feet ten or twelve; abdomen truncate.

ORDER CLADOCERA.

Body enclosed in a bivalve shell, head free; abdomen acutely forked; eye single, large. Lower antennae form large branched swimming organs; feet four to six pairs.

FAMILY DAPHNIADAE.

Upper antennae minute, one or two-jointed; five pairs of feet, all enclosed by carapace. Intestine nearly straight.

ORDER OSTRACODA.

Biting mouth, one eye, two pairs of antennae, one for swimming; bivalve carapace enclosing head and body. Feet one to three pairs.

FAMILY CYPRIDAE.

Upper antennae long, many-jointed, with a tuft of long hairs; lower stout and foot-like; two pairs of feet.

ORDER COPEPODA.

Body more or less distinctly segmented, and distinguishable into regions; two pairs of antennae, one or two antennae often prehensile. No carapace or bivalve shell; three pairs of mouth-parts and five pairs of swimming feet. Females with external egg-sac.

FAMILY CYCLOPIDAE.

Both anterior antennae modified for grasping in male. Posterior antennae four-jointed, not branched. Fifth pair of legs cylindrical, alike in both sexes. One eye, with two lateral lenses; two egg-sacs.

Genus Cyclops.

Body broad in front, slender behind, of ten segments in males, nine in females. Head and first thoracic segment consolidated. Palpus of mandible rudimentary, a tubercle bearing two bristles. Fifth pair of feet obsolete.

FAMILY HARPACTIDAE.

Body linear, cylindrical. Both anterior antennae of male modified for grasping. Posterior antennae branched, and armed with jointed bristles. The fifth pair of feet usually lamellate. Eye single. Commonly a single egg-sac.

Genus Canthocamptus.

Branches of the first pair of feet similar, three-jointed, the inner branch the longer, its first joint very long. Palpus of mandible simple, two-jointed. First antennae eight-jointed. Secondary branch of second antennae very short, one or two-jointed.

C. illinoisensis, Forbes. Minute, light red; five abdominal segments in male, four in female. Branches of furca (22) as wide as long. Of the bristles at their tip, the inner is about as long as the abdomen, the outer half the inner. Mandible with about ten teeth.

FAMILY CALANIDAE.

Body elongate; anterior antennae very long, usually of twenty four or twenty-five joints. In males the right—rarely the left—is modified for grasping. Posterior antennae large, two-branched. One egg-sac.

Genus Diaptomus.

Fifth pair of feet unlike in males, inner branch of right foot rudimentary or wanting. This foot is converted into a grasping organ, as is also the right antennae of the male. Antennae twenty-five jointed. Fifth thoracic segment distinct. Abdomen of male with five joints, of female with four.

D. sanguineus, Forbes. Color crimson. Right foot of male without inner ramus, the last two joints forming a hand and dactyl. Each branch of the furca bears six plumose hairs, of which the inner is slender and short. The teeth of the mandible are entire.

1. The crust covering cephalo-thorax on back and sides. 2. Under surface of head between the lower antennae. 3. Furnished with nippers. 4. Projection from front of head, between antennae. 5. In the male crawfish the first abdominal legs are stiff and unlike theothers; in the female similar to the others, but rudimentary. 6. Space on back of thorax between the two longitudinal curved lines. 7. Ridged longitudinally. 8. The many-jointed terminal part of antennae. 9 Front pair of jaws. 10. Jointed feelers. 11. Joint preceding hand. 12. Hind pairs of jaws. 13. The thick, longer-jointed basal part of antennae. 14. A very short flagellum attached beside the principal one. 15. Side-plates concealing attachment of legs. 16. Last joint claw-like, shutting against the enlarged preceding joint like the blade of a pocket-knife against its handle. 17. Rudimentary last segment of the body. 18. Under surface of the body between bases of the thoracic legs. 19. Undivided basal joint of leg. 20. Pair of appendages at tip of abdomen. 21. The strong, jaw-like organs in front of head. 22. The forked tip of the abdomen.

APPENDIX.

Descriptions of the following extra-limital species are added for the purpose of calling the attention of collectors to them, as it is very likely that they will be found in the state. The descriptions of crawfishes are furnished by Mr. Bundy, who has made a careful study of the species of Cambarus found in this and adjoining states.

C. sloanii, Bundy. Rostrum quadrangular, subdeflexed, slightly concave, toothed in front, acumen long, acute, straight, cephalo-thorax, finely punctate above, granulate on sides, front margin angulated, lateral tooth long, acute; epistoma wider than long, narrower in front, concave below, apex emarginate; third maxillipedes smooth below, hairy within, hands short, thick, wide, smooth, fingers short, straight, not gaping at base, generally tipped with black, arm and wrist nearly smooth, at most with a few blunt teeth; third legs with third joints hooked; first abdominal legs short, bifid, outer part slightly longer, flattened, bent outward at apex, slightly recurved, acute, tubercles at inner base small, inter-pedal space once and one-half longer than wide. The female has ventral ring rhomboid, posterior angle swollen, irregularly tuberculate, fissure transverse, anterior angle depressed. Habitat: Southern Indiana, Kentucky (*Dr. Sloan*).

C. debilis, Bundy. Rostrum wide, quadrangular, subdepressed, concave above, foveola at base, margins nearly parallel, anterior teeth prominent, acumen acute, flat, smooth, cephalo-thorax subdepressed, punctate above, granulate on sides, lateral tooth acute, dorsal area narrow, wider behind,

antennal plates longer than rostrum, apical spine acute; antennae slender, long, reaching to base of telson, epistoma much wider than long, truncate, maxillipedes barbate on inner side and below; inner margin of hand and movable finger with two rows of teeth, contiguous margins of fingers tuberculate, exterior one hairy at base, both fingers ribbed and punctate above, third joint of third thoracic legs hooked; first abdominal legs long, bifid, nearly straight, exterior part longer, recurved, interior part recurved, obtuse, not enlarged near apex, tubercles on inner basal angles small. This species resembles the above, but differs from it in having a wider, more concave rostrum, with parallel sides, a depressed dorsum, wider epistoma, more coarsely bearded maxillipedes, longer abdominal legs, and the absence of enlargement near apex of interior part. Habitat: Baraboo river, Ironton; Wisconsin river, Sauk City, Wisconsin.

Eubranchipus bundyi, Forbes. This species, sent me by my friend Prof. Bundy, was taken by him at Jefferson, Wis. The specimens seen were somewhat smaller than average individuals of *E. serratus*, the thorax shorter and the abdomen more slender. The latter is similar to the abdomen of *E. vernalis*, while the claspers and frontal appendages are more like those of *E. serratus*.

The *antennae* extend about one-third their length beyond the eyes. The *frontal appendages* are long and narrow, widest at base and regularly tapering, serrate within and on outer margin of tip with short blunt even teeth. The under surface is covered with short blunt spines or tubercles.

These appendages are attached by a transverse line to the front of the head, just within the base of the claspers, and are about three times as long as the basal joint of the latter.

The *claspers* resemble in size, general form and position those of *E. serratus*. The tubercle at the base of the first joint is larger and situated farther forward, extending far enough to the front to meet its fellow of the opposite side before the labrum. The opposed edges are somewhat roughened. The *labrum* is large and extends forward in the form of a stout tubercle, truncate at its extremity. This process is embraced by the concave posterior internal margins of the basal tubercles of the claspers The second joint of the clasper is thick at base, but tapers more rapidly than in *E. serratus*. The long and slender tooth of the latter is replaced by a thick rounded tubercle extending directly inward and covered by elevated disks, or truncate papillae, like the tip of the tooth in the species just mentioned. Unlike the latter, these papillae are wanting at the tip of the joint, which is expanded and distinctly bifid.

The margins of the *abdomen* are not distinctly serrate, the last segment is not connate with the penultimate, nor is the tip of the abdomen broader than the preceding segments.

The *caudal stylets* are broad and blunt, not rounded at base, usually a little longer than the last three abdominal segments, and ciliate their whole length. The ovisac of the female is nearly as broad as long, with a large median lobe behind, and no other posterior processes.

EXPLANATION OF THE PLATES.

ILLINOIS CRUSTACEA.

1, 2, 3, 4, 5, 6, 7, *Crangonyx mucronatus*, Forbes.

1. Head of female, with pedicels of antennae.
2. Posterior abdominal segments of male, with their appendages.
3. One of 1st pair of hands of male.
4. One of 2d pair of hands of male.
5. Telson and last pair of stylets of female.
6. One of 1st pair of hands of female.
7. One of 2d pair of hands of female.

8, 9, 10, 11, *Asellus brevicauda*, Forbes.

8. Hand of male, × 20.
9. One of 1st pair of genital plates of male, × 38.
10. One of 2d pair of genital plates of male, × 19.
11. One of caudal stylets.

12, 13, 14, 15, 16, *Asellus intermedius*, Forbes.

12. Hand of male, × 45.
13. Hand of female.
14. Last segment of abdomen, with caudal stylets, × 17.
15. One of 1st pair of genital plates of male, × 38.
16. One of 2d pair of genital plates of male, × 38.

17, 18, *Asellus communis*, Say.

17. One of 1st pair of genital plates of male, × 18.
18. One of 2d pair of genital plates of male, × 18.

19, 20, *Asellus stygius*, Pack.

19. One of 1st pair of genital plates of male.
20. One of 2d pair of genital plates of male.

21, 22, 25, *Eubranchipus serratus*, Forbes.

21. Abdomen, × 3.
22. Frontal appendage of male, × 10.
25. Claspers of male, from before, × 6.

23, 26, 27, 31, *Canthocamptus illinoisensis*, Forbes

23. One of 5th pair of legs of female.
26. One of anterior maxillipeds, × 250.
27. One of 3d pair of legs of male.
31. One of posterior maxillipeds.

24, 28, 29, 30, *Diaptomus sanguineus*, Forbes.

24. One of posterior maxillipeds.
28. One of anterior maxillipeds, × 66.
29. 5th pair of legs of male.
29a. Tip of inner ramus of left leg.
30. One of 5th pair of legs of female.

PARASITIC FUNGI.

PLATE I.

1, 2, 3 & 4, *Cystopus candidus*, Lev.

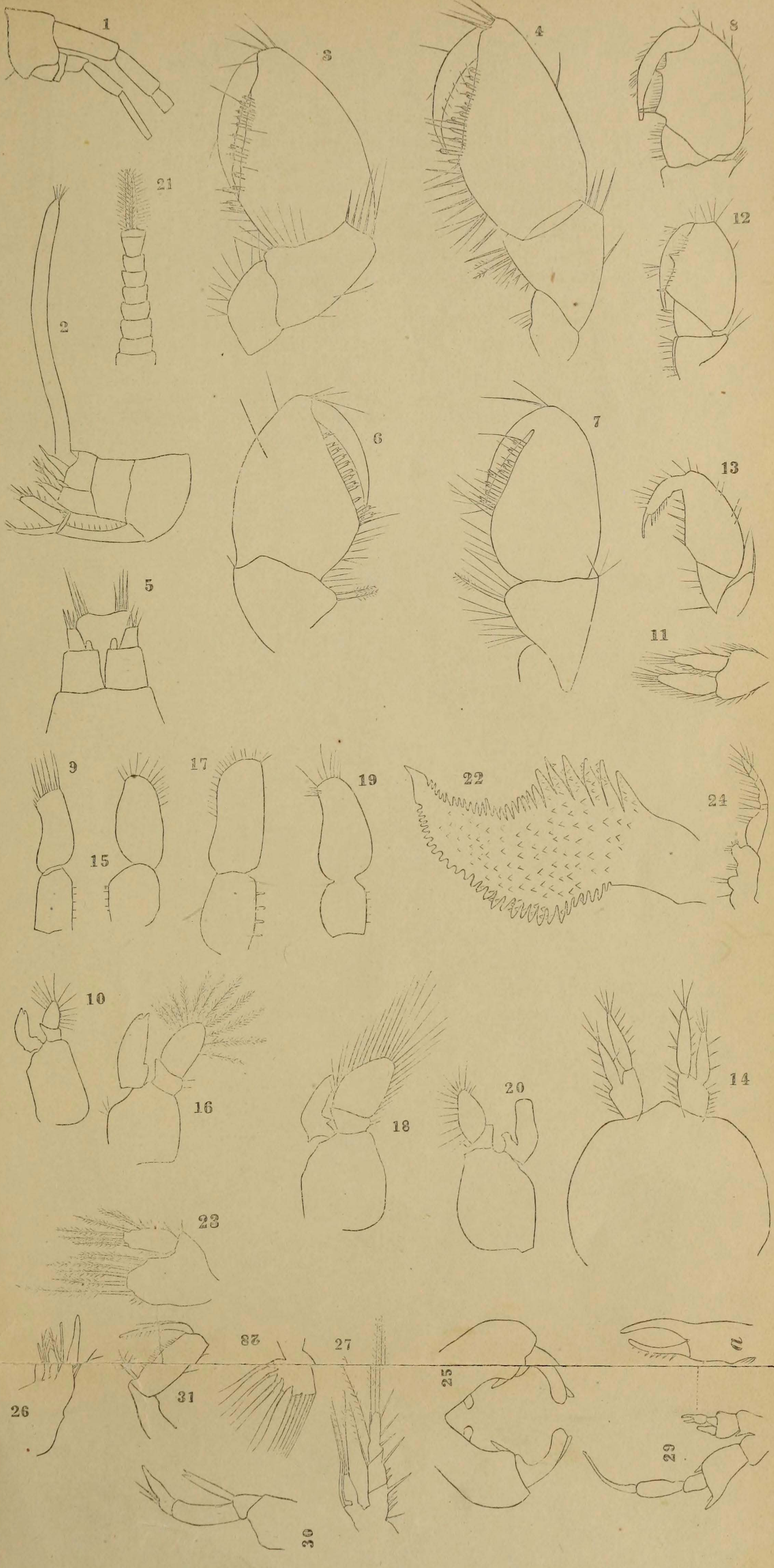
1. Portion of cabbage leaf with spots and holes caused by fungus.
2. Conidia, magnified 360 diam. After Cooke.
3a. Oogonium; 3b, antheridium; 3c, oospore, magnified 400 diam.
4. Oospore (the developed oosphere) ruptured, exhibiting zoospores, magnified 400 diameters. After De Barry.
4a. Free zoospores from oospore. 3 & 4 after De Barry.

5, 6, 7, 8, 9, 10 & 11, *Undetermined Parasite on Green-house Plants.*

5. Portion of petiole of geranium, with fungus; natural size.
6. Fertile hyphæ and conidia, magnified about 175 diam.
7. Conidium magnified 650 diam.
8. Conidium twelve hours after sowing in water, outer coat ruptured and the inner protruding in the form of a tube, magnified 320 diam.
9. Same conidium, thirty hours after sowing, magnified 325 diam.; germinating tube issuing from two points.
10. Supposed oospore, (see text) magnified 390 diam.
11. Longitudinal section of stem of Achyranthus, with mycelium, especially following the vascular bundles, a. Also seen penetrating cells of pith, c.

PLATE II.

1. *Melanispora populina*, Lev. a, Portion of leaf of Populus monilifera, natural size; b, Summer spores.
2. *Botryopium pulchrum* (?) Corda. Magnified about 75 diam.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