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## PRACTICAL EXAMINATION # 3: ORGANISMAL LABORATORY

**This practical examination is composed of 4 Tasks:**

**Task 1:** Dissection of the mouthparts of a grasshopper. **(10 points)**

**Task 2:** Relationship between form, function and ecology in some insect groups. **(10 points)**

**Task 3:** Identification of insects to species using a dichotomous key. **(14 points)**

**Task 4:** Vector efficiency of *Anopheles* mosquitoes in the transmission of malaria. **(6 points)**

**Total Points available: 40**

**Total time available: 90 minutes**

## GENERAL INSTRUCTIONS

Competitors are advised to read the examination before commencing.

It is recommended that Competitors proportion their time according to the allotted points for each task and question.

**IMPORTANT**

All answers must be recorded on the answer sheets provided.

Ensure that your 3 digit code number is written and coded on the top of each page of the answer sheets.

Using the pencil provided, fill in the appropriate circle on the answer sheet.

**TASK 1. Dissection of the mouthparts of a grasshopper. (10 points)**

**Introduction**

Grasshoppers are examples of insects with chewing mouthparts. For this task you will be required to complete three activities.

i. Identify, dissect out, and display the individual components of the grasshopper mouthparts and arrange them as shown in Figure 1 below. **(5 points)**

ii. Label the dissected mouthparts with the numbered pins according to the numbered names in Table 1. **(3.5 points)**

iii. Identify the functions of some of the mouthparts. **(1.5 points)**

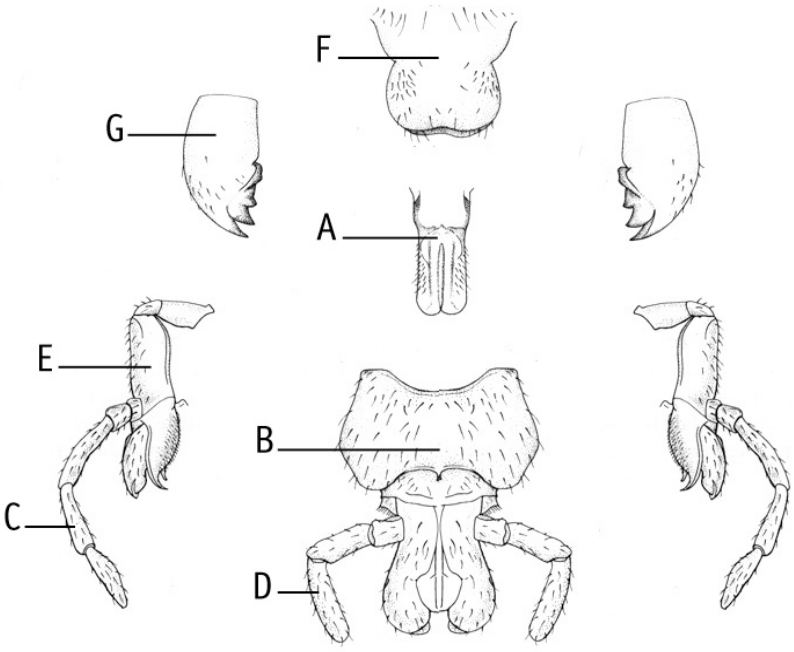
**Materials and Equipment**

1. Grasshopper *(Valanga irregularis)*
2. A set of instruments (2 pairs of forceps, 2 dissecting needles, 1 pair of scissors)
3. Dissecting dish
4. Unnumbered pins for holding the specimen in place in the dissecting dish
5. Pins marked I – VII
6. Latex gloves
7. Dissecting microscope
8. A piece of white foam on which to display mouthparts
9. Piece of paper to indicate competitors number

**Table 1. Names of mouthparts**

| Code | Name of mouthpart |
|---|---|
| I | Mandible |
| II | Labial palp |
| III | Labrum |
| IV | Hypopharynx |
| V | Maxilla |
| VI | Maxillary palp |
| VII | Labium |

**Figure 1. Labelling of grasshopper mouthparts**



**TASK P3.T1.1**

1. Remove the head from the grasshopper body – **(Please Note, you are allocated only one grasshopper for this task.)**

   With a pin secure the head, anterior down, in the wax dissecting dish.

   Identify the most posterior component of the mouthparts. Insert your forceps underneath and remove the part at its base.

   Working forwards, remove each component in turn by grabbing it at its base with your forceps (as close to the head capsule as possible) and pulling it off.

**NOTE**. Your dissection and display will be photographed, assessed and recorded on a special control sheet by an attendant. The correctness of the mouthparts preparation and presentation will be scored. Points will be lost for damage to parts or failure to remove all parts.

If the attendant is busy with another participant, continue with the next task while waiting to have your dissection assessed.

2. Arrange the parts on the piece of white foam as shown in Figure 1.
3. Label the dissected parts with the numbered pins according to the number code in Table 1.
4. Write your competitor number on the piece of paper pinned to the foam.
5. Display the tick [✓] on the green card to indicate to the attendant that you have completed this task.
6. Place your dissection to the side of your bench for assessment.

**(5 points)**

**TASK P3.T1.2 I**dentify the parts A – G of Figure 1 using the number code for the appropriate part from Table 1.

| Labelled Mouthpart | Code for name of mouthpart |
|---|---|
| A | |
| B | |
| C | |
| D | |
| E | |
| F | |
| G | |

**(3.5 points)**

**Enter your answer on the answer sheet.**

**TASK P3.T1.3** By studying each of the mouthparts, determine the primary function. Use the code number from Table 1 to complete the table below.

| Primary function | Code for name of mouthparts |
|---|---|
| Grinding and crushing of food | |
| Acting as a tongue | |
| Acting as a top lip to form part of the mouth cavity | |

**(1.5 points)**

**Enter your answer on the answer sheet.**

**TASK 2. Relationship between form, function and ecology in some insect groups. (10 points)**

**INTRODUCTION**

In this task you will investigate the relationship between form, function and ecology in some insect groups. The task is divided into two parts, Task 2A and Task 2B

**Task 2A Determination of the function of insect legs (5 points)**

**Introduction**

In Task 2A you will study the relationship between the function and structure of the legs of different insects.

**Materials and Equipment**

1. A board with 8 insect specimens labelled I – VIII
2. Dissecting microscope
3. Slide with plasticine to hold specimens

**TASK P3.T2.1** Study the pinned insect specimens provided. To examine each insect, pin the specimen into the mound of plasticine on the glass slide and place under the dissecting microscope. Change the position of the pin to view the insect from different angles. To study the underneath of the specimen, turn the pin upside down and insert the head of the pin into the plasticine. The insect specimens are labelled I – VIII. These insects belong to a number of different orders and have hind or fore legs modified for special functions. Table 2a below presents a list of these special functions (Codes A – E) and Table 2b provides list of leg modifications necessary to perform the special functions (Codes a – e). Figure 2 explains the terminology used in Table 2b.

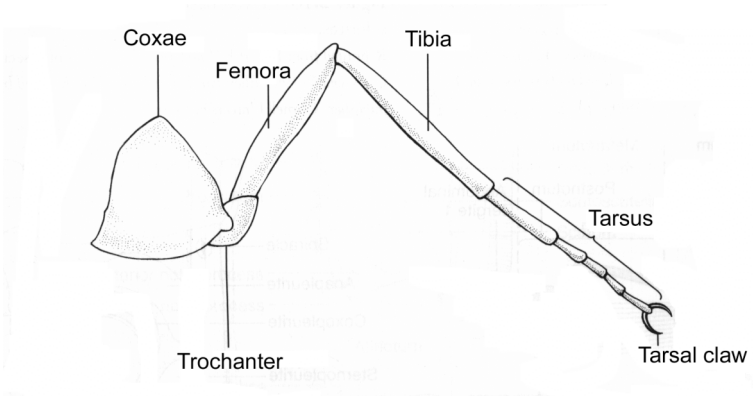
*Table 2a. Leg functions*

| Code | Function |
|---|---|
| A | Fossorial (digging) |
| B | Raptorial (for seizing prey) |
| C | Saltatorial (jumping) |
| D | Gressorial (walking) |
| E | Natatorial (swimming) |

*Table 2b. Modifications of leg structure*

| Code | Modification |
|---|---|
| a | Legs flattened with fringes of hairs/setae |
| b | Legs with long, narrow coxae, femora with strong spines on ventral surface |
| c | Legs short, thickened, spined |
| d | Legs long with muscular femora |
| e | All legs similar in shape and size |

**Figure 2 Terminology of Insect Leg**




**By closely observing the insect specimens, for each insect leg function (A-E), select one insect specimen (I-VIII) that has such legs and the type of modification (a-e)**

| Leg Function | Insect specimen | Leg modification |
|---|---|---|
| A. Fossorial (digging) | | |
| B. Raptorial (for seizing prey) | | |
| C. Saltatorial (jumping) | | |
| D. Gressorial (walking) | | |
| E. Natatorial (swimming) | | |

**(5 points)**

**Enter your results on the answer sheet.**

**Task 2B. Relationship between the external morphology and ecology of two ectoparasites**

**(5 points)**

**Introduction**

Fleas and lice are both external insect parasites of vertebrates. A louse is an example of a parasite that spends its entire life cycle on its host. A flea is an example of a parasite that does not spend its entire life cycle on its host. Each possesses morphological adaptations to suit its respective feeding style and host-associated habitat. This Task examines some of these morphological adaptations and how they relate to the biology of these insects.

**Materials and Equipment**

1. 2 slide-mounted specimens
    i) a cat flea (*Ctenocephalides felis*) and
    ii) a poultry louse (*Menopon gallinae*)
2. A compound microscope

**TASK P3.T2.2** Using the microscope, examine the flea and louse specimens and determine if the characteristics in the table below are **present (+)** or **absent** (-) in each specimen.

| **Character/Modification** | **Flea** | **Louse** |
|---|---|---|
| body dorsoventrally compressed | | |
| tarsal claws | | |
| comb-like row of spines on head | | |
| body with distinct bristles/setae | | |
| elongate mouthparts | | |
| obvious eyes | | |

**(3 points)**

**Enter your results on the answer sheet.**

**QUESTION P3.T2.3** On the basis of your observations, which of the following combinations of characters would be most important for a parasite that spends its entire life cycle on its host?

**(1 point)**

**A.** Eggs scattered throughout host's hair/feathers; legs modified for gripping; body dorso-ventrally compressed; compound eyes reduced/absent

**B.** Eggs cemented onto host's hair/feathers; legs modified for jumping; body dorso-ventrally compressed; compound eyes well developed

**C.** Eggs scattered throughout host's hair/feathers; legs modified for gripping; body laterally compressed; compound eyes reduced/absent

**D.** Eggs cemented onto host's hair/feathers; legs modified for gripping; body dorso-ventrally compressed, compound eyes reduced/absent

**E.** Eggs cemented onto host's hair/feathers; legs modified for jumping; body laterally compressed; compound eyes well developed.

**QUESTION P3.T2.4**. Which combination of characters would most likely be found in an adult parasite that feeds only on blood? **(1 point)**

**A.** Piercing and sucking mouthparts; chewing mandibles absent; digestive tract with specialised area for grinding; muscular pumps to suck blood

**B.** Non-piercing mouthparts; chewing mandibles absent; digestive tract not modified for grinding; muscular pumps to suck blood

**C.** Piercing and sucking mouthparts; chewing mandibles absent; digestive tract not modified for grinding; muscular pumps to suck blood

**D.** Non-piercing mouthparts; chewing mandibles present; digestive tract not modified for grinding; no pumps to suck blood

**E.** Piercing and sucking mouthparts; chewing mandibles present; digestive tract not modified for grinding; muscular pumps to suck blood

**TASK P3.T3 Identification of ants to species using a dichotomous key. (14 points)**

**Introduction**

Ants are an important part of most terrestrial ecosystems. They occur in large numbers and are found in soil, on the surfaces and on vegetation. They can occur around homes where they may be considered pests but they are gaining increasing significance as bioindicators. For these reasons, their accurate identification is often required.

**Materials and equipment**

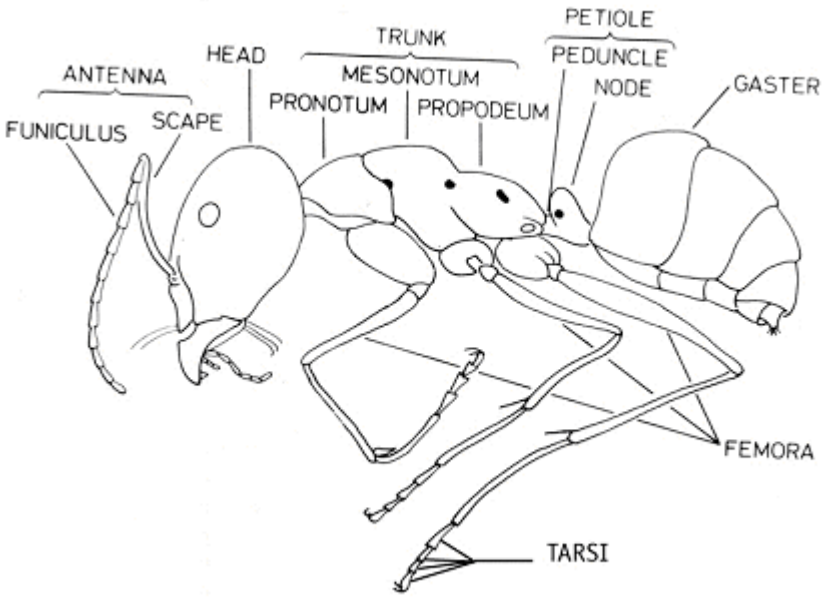
1. A tray with 10 species of ants in ethanol numbered I - X.
2. A dissecting microscope
3. A dichotomous key
4. A set of instruments (2 pairs of forceps, 2 dissecting needles, a ruler)
5. 3 glass dishes for studying ants under the microscope
6. Plastic pipette

**Task P3.T3.1**

You are provided with 10 specimens of ants (numbered I to X) and a dichotomous key to ant species, including the species provided. Figure 3 explains the terminology used in the key.

Identify the ants using the key. You may remove the ants from the vials and place in the glass dishes for viewing under the microscope. When you have identified each specimen, enter your answer on the answer sheet by filling in the letter code corresponding to the species identified.

**Figure 3: Ant anatomy and terminology.**



## IDENTIFICATION KEY TO ANT SPECIES

1. Head and gaster with distinct metallic green or purple lustre; surface of head, trunk and petiole pitted and rough ..... *Rhytidoponera metallica*

   Head and gaster not with distinct metallic green or purple lustre; surface of head, trunk and petiole not pitted and rough ..... 2.

2. Colour mainly black or dark brown ..... 3.

   Colour mainly yellow-brown or distinctly black and orange ..... 6.

3. Ant length no more than about 3-4 mm ..... 4.

   Ant length more than 5 mm ..... 5.

4. No node on abdominal petiole; tarsi pale yellowish, distinctly paler than femora ..... *Technomyrmex albipes*

   Abdominal petiole with a single node; tarsi brown ..... *Ochetellus glaber*

5. Propodeum smooth and rounded, without spines ..... *Camponotus aeneopilosus*

   Propodeum with distinct spines ..... *Polyrhachis* sp.

6. Abdominal petiole 1-segmented; funiculus without a distinct elongate terminal 3-segmented club ..... 7.

   Abdominal petiole 2-segmented; funiculus usually with a distinct elongate terminal 3-segmented club ..... 9.

7. Gaster pale yellow-green ..... *Oecophylla smaragdina*

   Gaster black ..... 8.

Please refer to next page for couplets 8 to 11

8. Gaster and head black; trunk and petiole orange/brown..... *Camponotus consobrinus*

   Gaster and petiole black; head and trunk orange/brown..... *Iridomyrmex purpureus*

9. Propodeum with distinct spines or teeth-like projections ..... 10.

   Propodeum without distinct spines or teeth-like projections ..... 11.

10. Head and gaster greyish black..... *Pheidole* sp.

    Head and gaster pale brown ..... *Pheidole megacephala*

11. Funiculus with a distinct terminal 3-segmented club ..... *Monomorium pharaonis*

    Funiculus without a distinct terminal 3-segmented club..... *Monomorium destructor*

**(14 points)**

**TASK 4. Vector efficiency of *Anopheles* mosquitoes in the transmission of malaria**

**(6 points)**

**Introduction**

Malaria is regarded as one of the most prevalent and destructive diseases in the tropics, with over 40% of the world's population being at risk of infection. The disease is transferred between humans by mosquitoes, with the main vectors belonging to the genus *Anopheles.* More than 422 species of *Anopheles* have been described, of which 68 have been identified as vectors of malaria. Species differ in their efficiency as vectors, with some being primary or main vectors, and others acting as secondary or less important vectors. Factors that determine efficiency as vectors include distribution, feeding and habitat preference, the time of biting and malarial stability.

Table 4a shows the influence of time of biting and habitat preference on vector efficiency.

**Table 4a: Influence of time of biting and habitat preference on vector efficiency**

| **Species** | **Time of Biting** | **Habitat Preference** | **Vector Efficiency** |
|---|---|---|---|
| *Anopheles 1* | 10pm - 4am | exophilic | low |
| *Anopheles 2* | 10pm - 4am | endophilic | high |
| *Anopheles 3* | 9am – 4pm | endophilic | medium |

***Glossary of terms:***

**Anthropophilic:** Likes to feed on humans

**Zoophilic:** Likes to feed on animals

**Endophilic:** Likes to feed and rest indoors

**Exophilic:** Likes to feed and rest outdoors

**Malaria Stability:** the chance of the mosquito surviving long enough for the malarial parasite to become infective. A low value represents unstable malaria, meaning the mosquito dies before it is capable of spreading infection.

**TASK P3.T4.1** Based on the information in Table 4a, the glossary above and the Table below, rank the six species of *Anopheles* (*Anopheles a – Anopheles f*) on the answer sheet in rank order where rank 1 is the **most efficient malaria vector** and rank 6 is the **least efficient malaria vector**.

| Species | Distribution | Feeding Preference | Habitat Preference | Time of Biting | Malaria Stability |
|---|---|---|---|---|---|
| *Anopheles a* | wide | highly anthropophilic | endophilic & exophilic | 9am - 4am | 2.5 |
| *Anopheles b* | wide | moderately anthropophilic | exophilic | 9am - 4pm | 1.8 |
| *Anopheles c* | wide | zoophilic | exophilic | 9am - 4pm | 0.5 |
| *Anopheles d* | restricted | moderately anthropophilic | endophilic | 9am - 4pm | 1.5 |
| *Anopheles e* | wide | highly anthropophilic | endophilic | 10pm - 4am | 1.8 |
| *Anopheles f* | wide | zoophilic | exophilic | 9am - 4pm | 1.2 |

**(3 points)**

**TASK P3.T4.2** Figure 4 below is a map of several proposed sites for the construction of a tourist camp site in an area where *Anopheles* mosquitoes are found. Table 4b summarises the climatic conditions of each site. Table 4c lists the five common species of *Anopheles* (*AnophelesI – AnophelesV*) found in the vicinity of the five sites. All five species are known vectors of malaria.

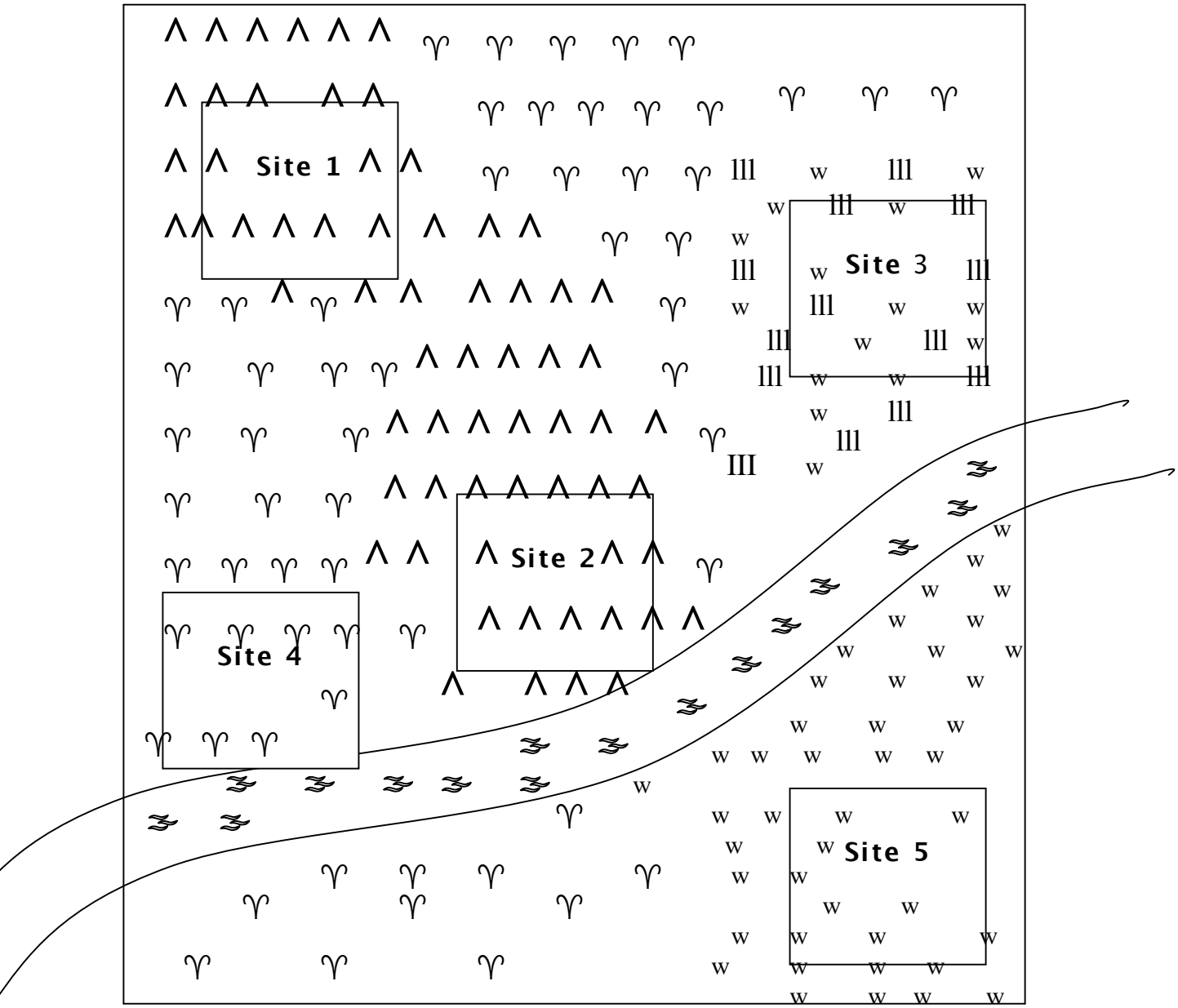
**Table 4b: Summary of climatic conditions at each proposed campsite**

| Site | Altitude | Daily Max Temp. | Daily Min Temp | Monthly Rainfall |
|---|---|---|---|---|
| 1 | 650m | 20°C | 8°C | 150mm |
| 2 | 200m | 25°C | 13°C | 100mm |
| 3 | 50m | 28°C | 17°C | 300mm |
| 4 | 100m | 27°C | 15°C | <50mm |
| 5 | 50m | 27°C | 17°C | 300mm |

**Table 4c: Species information for *Anopheles***

| Species | Larval Habitat | Extra Information | Vector Efficiency |
|---|---|---|---|
| *Anopheles I* | swamps and stagnant pools of water | high mortality in temperatures <15°C | 0.71 |
| *Anopheles II* | water collected in tree holes and stems of plants | high altitude species (>400m) tolerates temperatures <10°C | 2.49 |
| *Anopheles III* | fast flowing water | high larval mortality in warm, unshaded waters | 0.22 |
| *Anopheles IV* | fast flowing water | can tolerate arid conditions and high temperatures | 6.54 |
| *Anopheles V* | swamps and stagnant pools of water | larvae shelter and feed on submerged vegetation | 1.36 |

**Figure 4: Location and vegetation layout of proposed camp sites.**




**LEGEND**

| | |
|---|---|
| ^ ^ | Forested areas |
| w w w | Swampy area |
| lll | Low growing, semi-submerged aquatic vegetation |
| ≈ | Fast flowing water e.g. stream/river |
| ϒ | Open grassland |

10km

Based on the information provided for each species of *Anopheles* (*Anopheles I – Anopheles V*), select the site (Site1- Site 5) where it is **most likely** to occur. There is only one correct site for each species of *Anopheles.* **(2 points)**

**Enter your answer on the answer sheet.**

**TASK P3.T4.3** Using the information provided select the best site (Sites 1 to 5) to locate a tourist camp site where the risk of contracting malaria would be the lowest, assuming that each species is confined to the one camp site and the maximum distance species can infect within is 10km.

**(1 point)**

**Enter your answer on the answer sheet.**