



Design Research Seminar Project: **Nature and Form**

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Acknowledgment

I would like to sincerely thank my project guide Prof. Nishant Sharma for his time, support and guidance throughout my project.

Special thanks to my friends and my classmates for their great help and support.

Great thanks to IDC for providing me with all kind of infrastructure and opportunity.

Declaration

I declare that this written submission represents my ideas in my own words and where others' ideas or words have been included, I have adequately cited and referenced the original sources. I also declare that I have adhered to all principles of academic honesty and integrity and have not misrepresented or fabricated or falsified any idea/data/fact/ source in my submission. I understand that any violation of the above will be cause for disciplinary action by the Institute and can also evoke penal action from the sources which have thus not been properly cited or from whom proper permission has not been taken when needed.

(Signature)

(Name of student)

(Roll number)

(Date)

Approval Sheet

Design Research Seminar Project:
Nature and Form

By:-Nikhil Das K.V
M.Des Industrial Design 2012-2014
126130007

is approved as a partial fulfilment of requirement of post graduate degree
in industrial Design.

Professor Nishant Sharma :
(Project Guide)

External Examiner:

Internal Examiner:

Chairperson:

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INTRTODUCTION

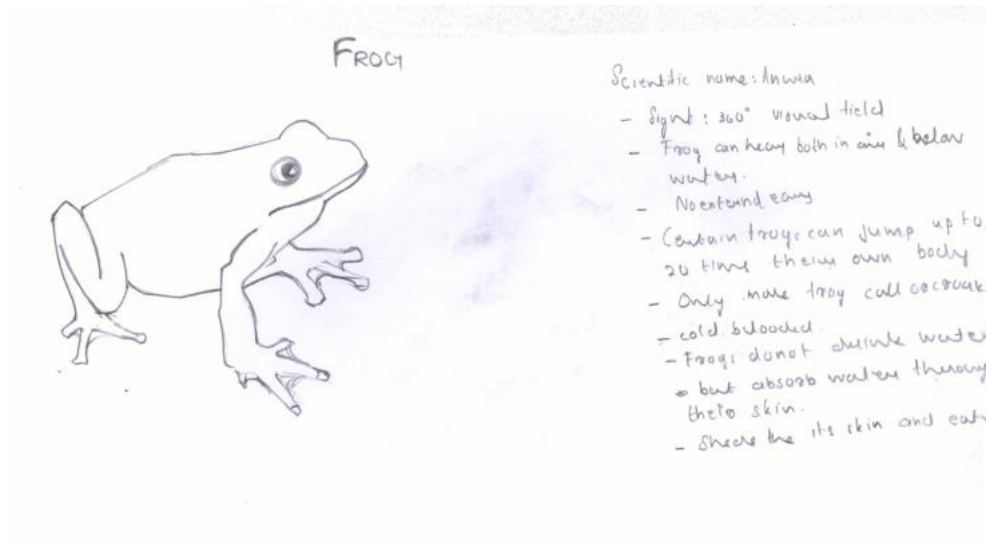
Design research seminar project is a part of final semester at IDC, IITB. I have opted 'Nature and Form' for my area of project because of the tremendous interest in bio-mimicry. The main objective of this project is to study one organism in-depth and identify specific characteristics or parts of it and find a design application for the characteristic.

Nature has solution for all kind of human needs. It is possible to solve all these needs by observing nature and how plants and animals tackle challenges of their environment. The word Biomimicry is very relevant in this present world technology and researches because nature is the best teacher who has gained experience through many years of evolution. The creative solution which inspired from the nature can be much more sustainable than others.

The discipline of Biomimicry takes its name from the Greek words 'bios' which means life and 'mimesis' which means to imitate. As its name might suggest, Biomimicry involves the study of nature's designs and mimicking them to solve human challenges. Janine Benyus, one of biomimicry's pioneers defines it as 'innovation inspired by nature'.

STUDYING EXAMPLES FROM NATURE

1.Frog



Scientific name: Anura

Rank: Order

Frog Facts

- Frogs absorb water through their skin so they don't need to drink.
- Frogs can lay as many as 4,000 eggs in frogspawn.
- The eyes and nose of a frog are on top of its head so it can breathe and see when most of its body is under the water.
- Frogs have long back legs and webbed feet for jumping and swimming.
- Certain frogs can jump up to 20 times their own body length in a single leap.
- Frogs usually eat meat (bugs and worms) and swallow their food whole.
- Amphibians' eyes come in all shapes and sizes. Some even have square or heart shaped pupils. But amphibians don't see colour -- they only see in black or white

Fig.1

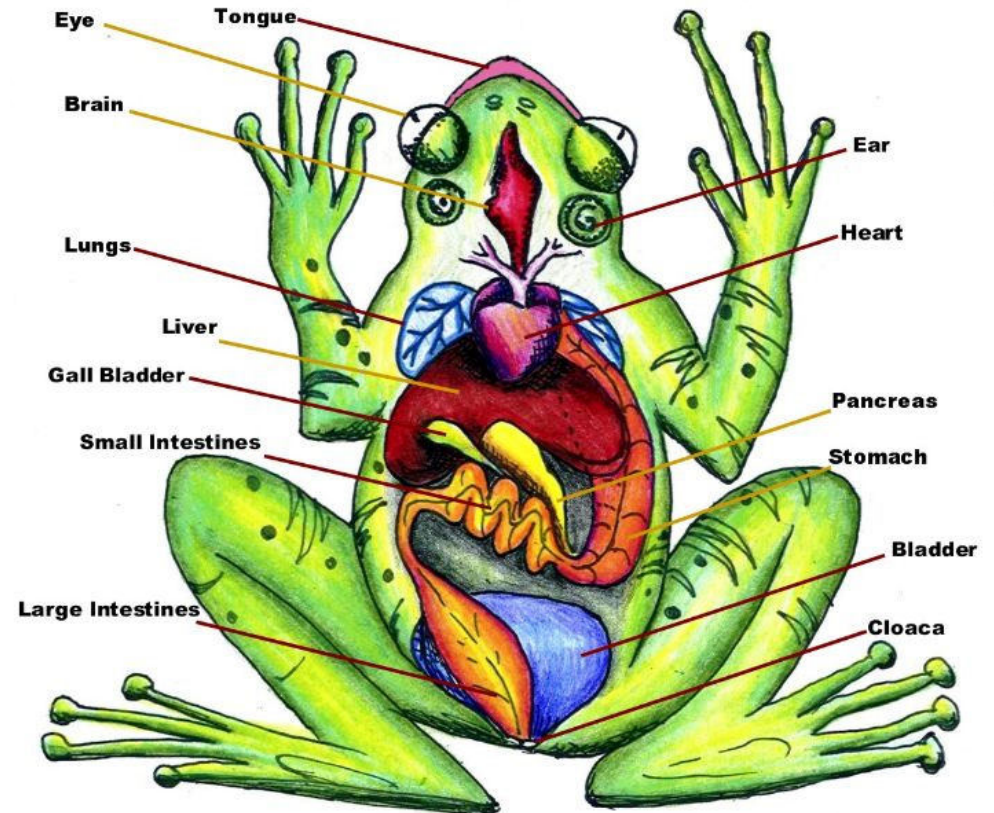


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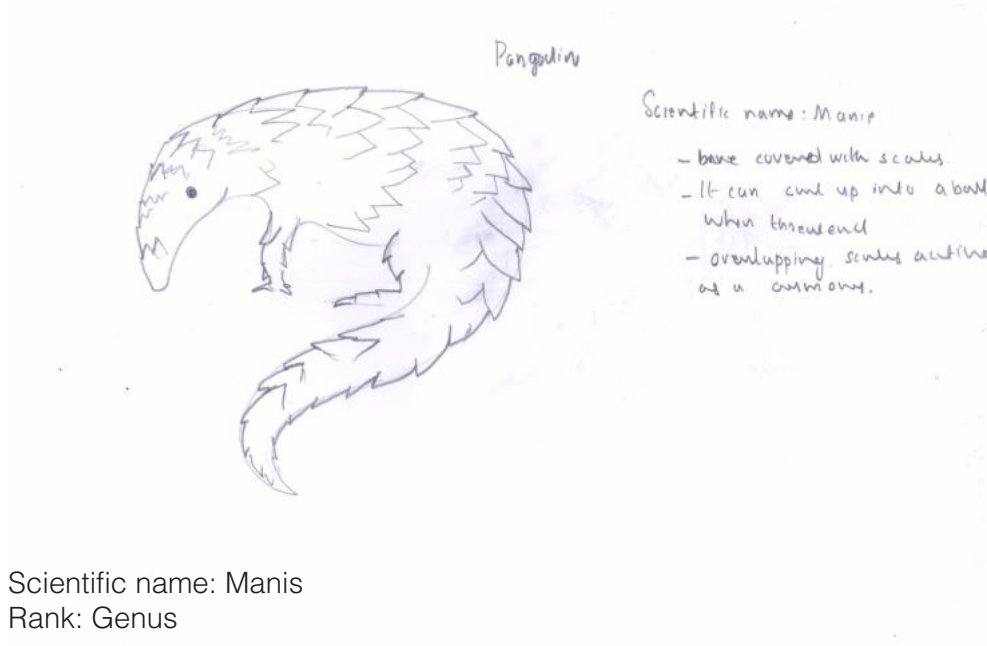
Fig.2 Frog anatomy

- One type of desert frog can wait as long as seven years for water by surrounding itself in a type of transparent bag that becomes its first meal once the rain comes
- In the Seychelles, there is a male frog that carries its young around on its back until they become adults

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Nature and Form 2

2. Pangolin



Pangolin Facts

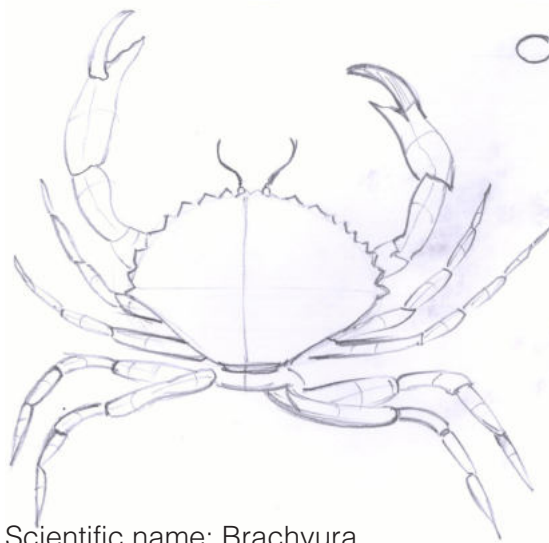
- Pangolins are insectivores, they mainly eat ants and termites.
- There are 8 species of pangolin
- The long claws on their front paws are longer and which are inappropriate for walking, so they often walk on their hind legs
- Pangolins have very poor eyesight, but they have very good sense of smelling
- Pangolins have prehensile tails, which helps to for hanging on tree branch
- Pangolins have longer sticky tongues, which can be up to 70cm long.
- Pangolins do not have teeth
- Pangolin scales are made of keratin

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3.Crab



CRAB

- Scientific name: Brachyura
- Crabs typically walk sideways.
- Segmented body.
- Compound eyes.
- having hard outer cover

Scientific name: Brachyura
Rank: Infraorder

CrabFacts

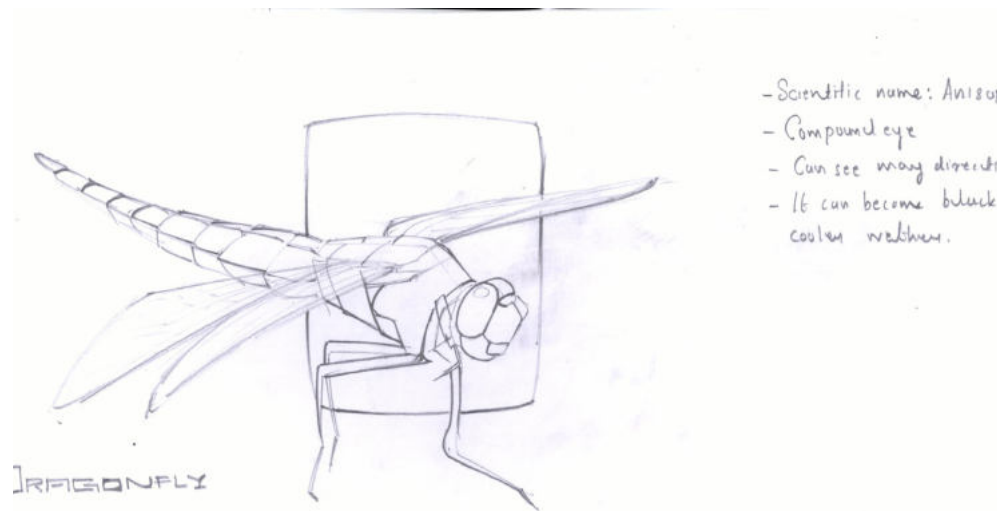
- Crabs are generally covered with a thick exoskeleton (composed primarily of calcium carbonate) and have a single pair of claws, they live in ocean, fresh water and on land
- Around 850 species of crab are freshwater, terrestrial or semi-terrestrial species
- Crabs typically walk sideways, the reason for this fact is articulation of the legs which makes a sidelong walk more efficient
- Certain types of crabs are capable of swimming
- Crabs are mostly active animals with complex behaviour patterns. They can communicate by drumming or waving their claws.



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- Crabs are omnivores, feeding primarily on algae and taking any other food, including molluscs, worms, other crustaceans, fungi, bacteria and detritus
- Crabs are known to work together to deliver food and protection for their family, and during mating season to find a comfortable spot for the female to release her eggs

4. Dragonfly



Scientific name: Anisoptera

Rank: Infraorder

Dragonfly Facts

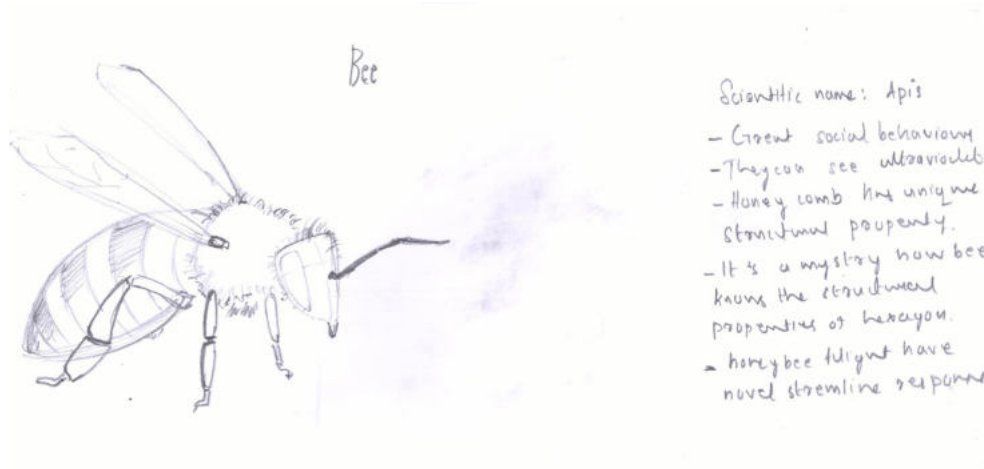
- The Southern Giant Darner flying at nearly 60 miles per hour, which can move each of their four wings independently
- Dragonflies are ancient insects.
- Dragonfly nymphs live in the water and dragonfly nymphs breathe through their anus
- Dragonflies have outstanding vision. The head consists almost entirely of two huge compound eyes, which gives the dragonfly nearly 360° vision
- Dragonflies are capable of thermoregulation.

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5. Honey Bee



Scientific name: Apis
Rank: Genus

Honey Bee Facts

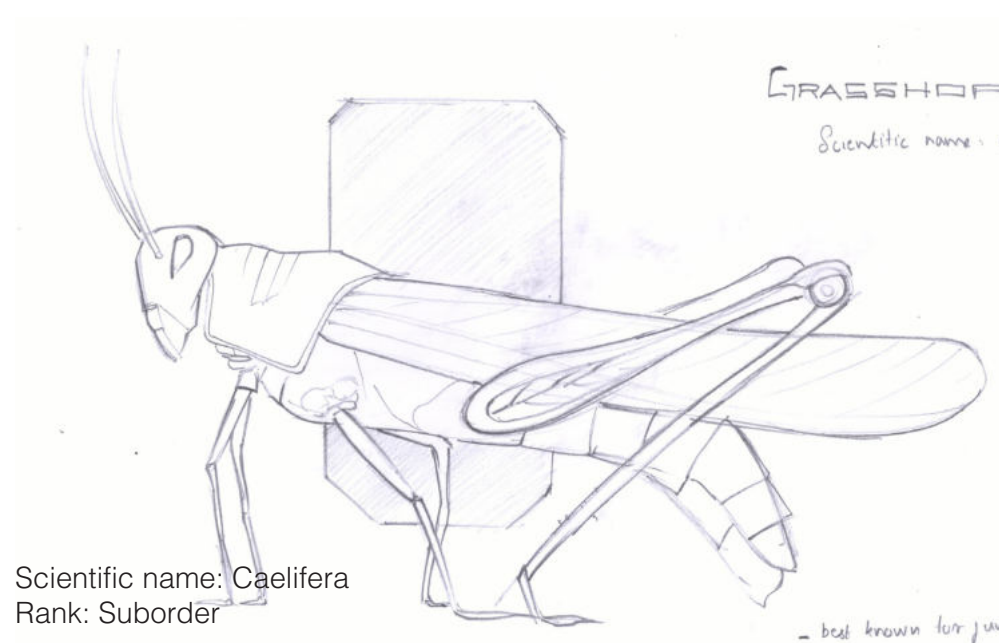
- Honey bees have 6 legs, 2 compound eyes made up of thousands of tiny lenses 3 simple eyes on the top of the head, 2 pairs of wings, a nectar pouch, and a stomach.
- The average worker bee produces about 1/12th teaspoon of honey in her lifetime
- The honeybee flight have a novel streamline response ,helping in saving considerable energy by reducing drag.
- Each honey bee colony has a unique odour for members' identification.
- Honey bees are known to communicate through many different chemicals and odours, as is common in insects, but also using specific behaviours that convey information about the quality and type of resources in the environment

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6. Grasshopper



Grasshopper Facts

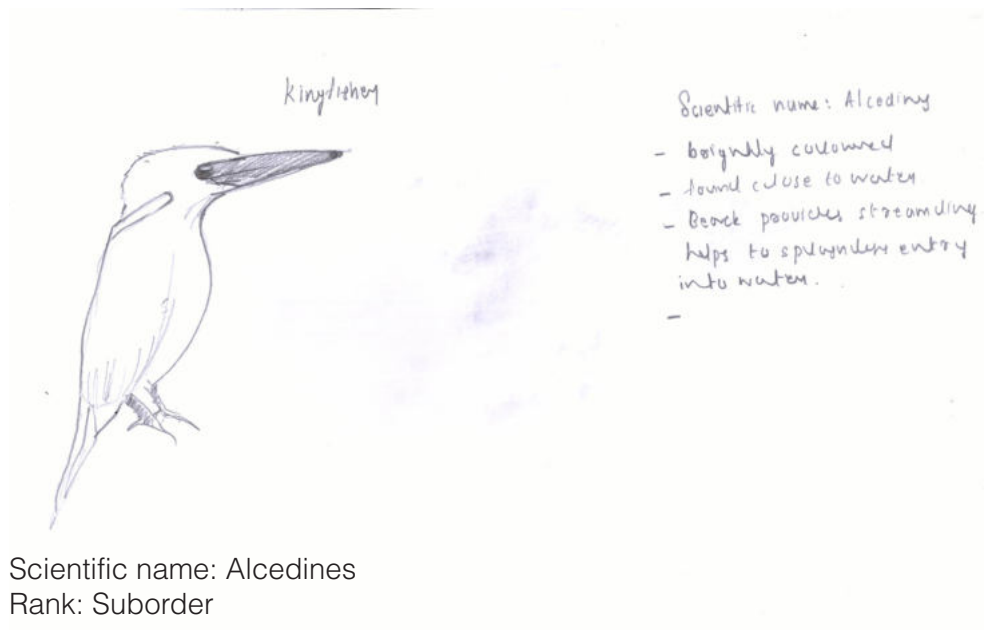
- Grasshopper makes sound by rubbing their wings or legs together.
- They can jump twenty times the length of their body.
- A small cuticle in a grasshopper's knee acts as a spring and lets it catapult its body into the air.
- Grasshoppers sometimes "spit" brown liquid to defend themselves
- Females have two pairs of valves (triangles) at the end of the abdomen used to dig in sand during egg laying
- Grasshoppers have ears on their bellies, although grasshoppers can hear, they can't distinguish pitches very well.

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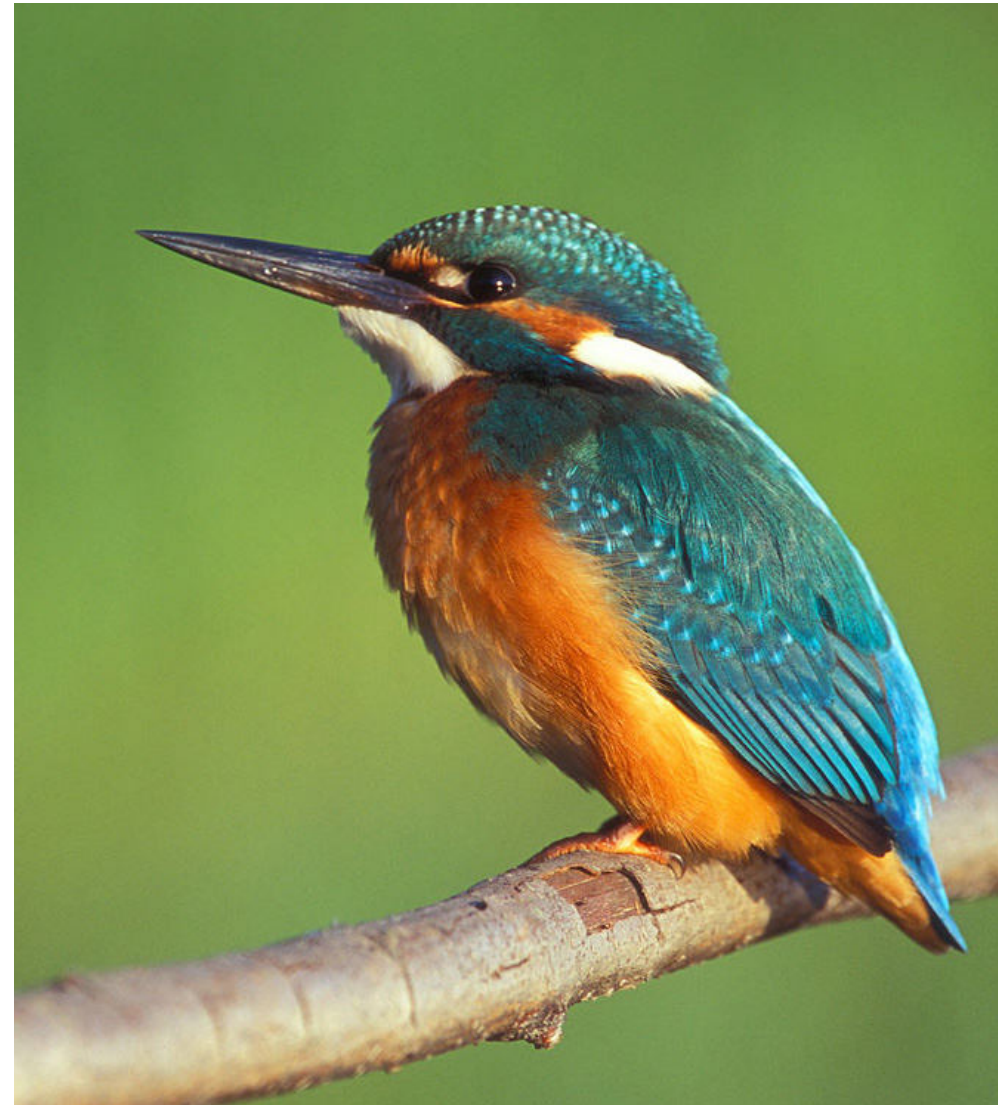
8. Kingfisher



Kingfisher Facts

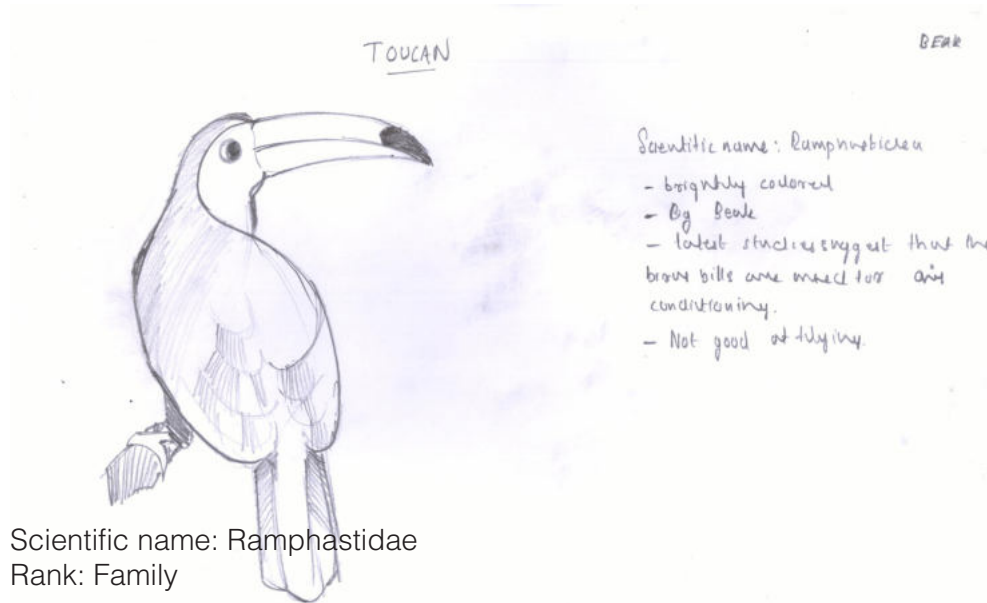
- Kingfishers are water specialists, they nest close to clean rivers, streams, lakes and ponds
- They feed almost exclusively on fish, but will also take small invertebrates
- The flight is very fast and low with extremely rapid wing beats
- Kingfishers are territorial, some species defending their territories vigorously
- The kingfisher can hover just above the water before diving in for its prey
- The beak of kingfishers allows splashless entry into water due to the wedge shape it makes with the head that is round in cross section.
- The wings are smaller in terms of wingspan as it allows the able to dive better, faster and catch its prey better

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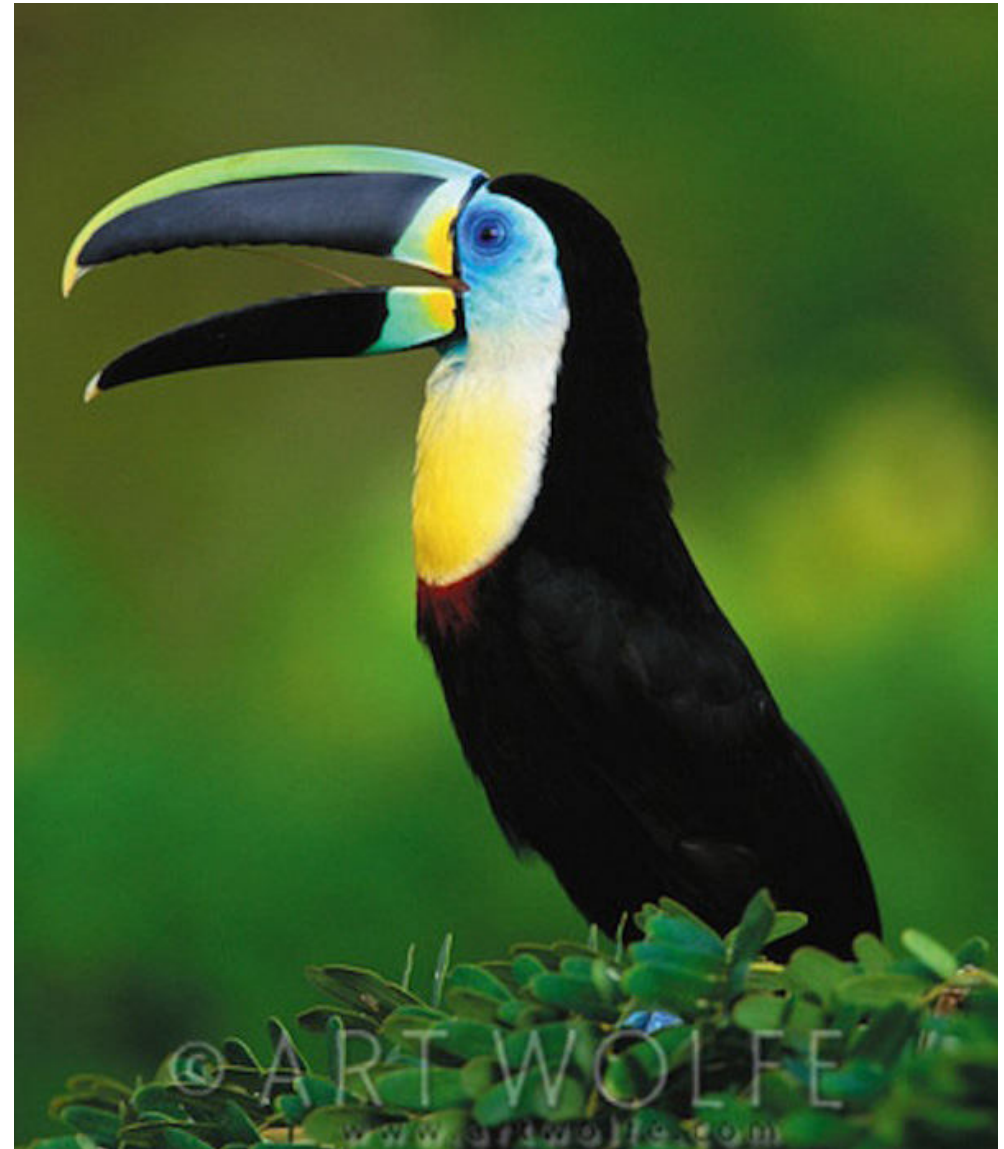
9. Toucan



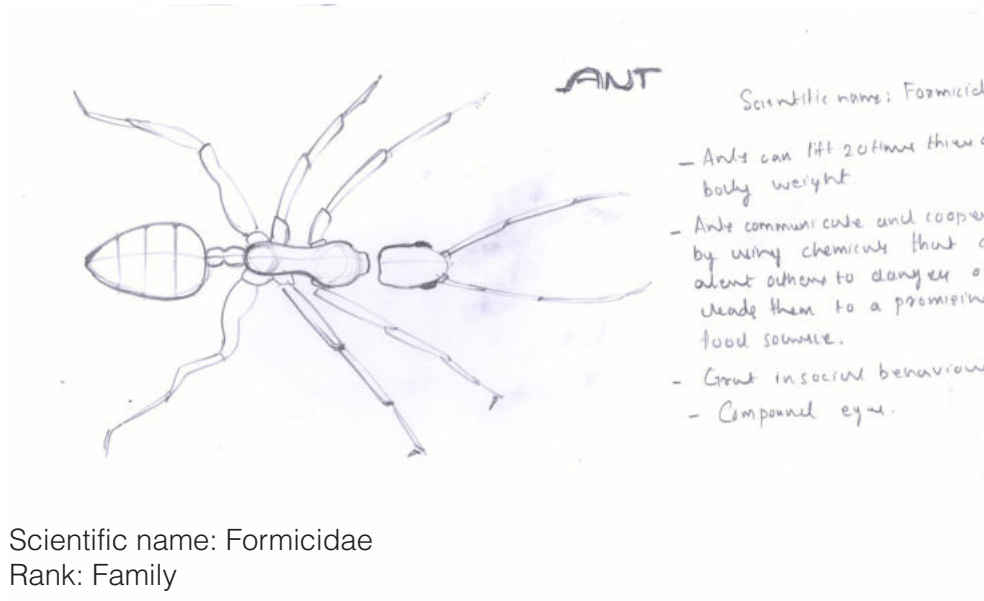
Toucan Facts

- Toucans have larger bills, in comparison to the size of their body, than any other bird in the world.
- Their bright colourful markings provide them with excellent camouflage in the rainforest
- Toucans have sharp strong claws which enable it to hold tightly onto branches.
- Toucans are omnivorous, their main food source is fruit
- Toucans build their nest in tree hollows created by other animals; generally in the rainforest canopy
- Their large bill helps them keep cool in the hot environment in which they live. This adaptation is one of the best heat regulating systems in the entire animal kingdom.

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10.Ants



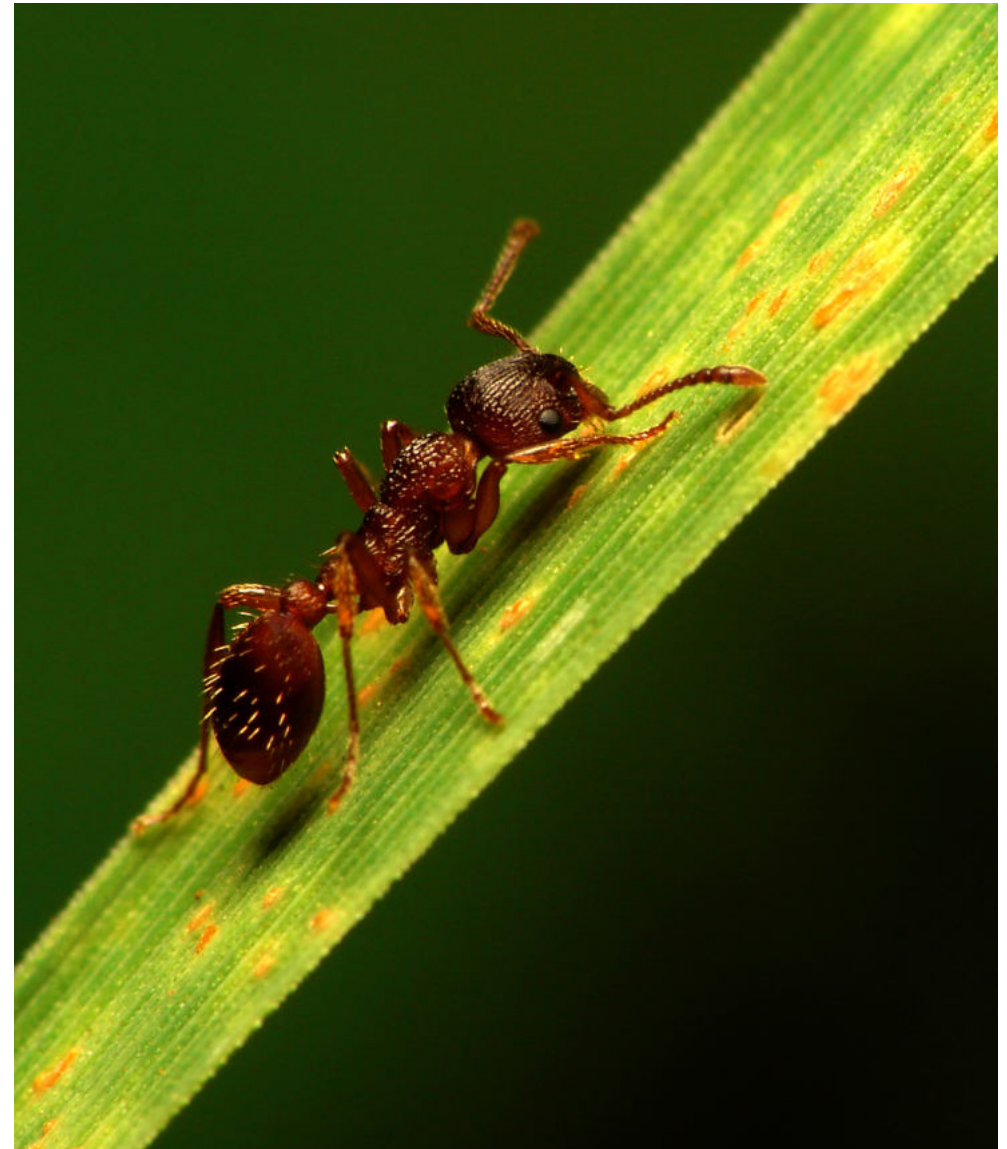
Scientific name: Formicidae

Rank: Family

Ant Facts

- Ants are social insects which form colonies that range in size
- Ants live all over the world, except for Antarctica and also the arctic
- Ants have 6 legs and their bodies are divided into three segments consisting of the head, thorax, and abdomen.
- Ants are capable of carrying objects 50 times their own body weight with their mandibles
- Ants communicate and cooperate by using chemicals (pheromones) that can alert others to danger or lead them to a promising food source
- Ants can travel up to 2 miles in a day
- Ants have compound eyes - each eye is made of many smaller eyes.

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Dragonfly:-Inspiration for Project

I have taken Dragonfly as an organism for my projects and further re-search. The basic idea was find out adaptable features of the dragonflies and find a design application for this adaptable feature. I have chosen Dragonfly because of its specific adaptable characteristics. Dragonfly is known for its speed and vision. Dragonflies can move forward at a rate of approximately 100 times their own body length each second, sometimes reaching speeds of around 55 miles per hour. Dragonflies have extremely large eyes for their size, covering the majority of their heads. The adaptation in the nymph stage also a fascinating feature of dragonfly.



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Source: <http://goo.gl/3qwIKc>

Dragonfly Life Cycle

A dragonfly has a life span of more than a year, but very little of that life is actually as an adult dragonfly. There are three stages of the dragonfly life cycle, the egg, the nymph, and the adult dragonfly. Most of the life cycle of a dragonfly is lived out in the nymph stage

The egg stage:

In this stage male dragonfly mate with female dragonfly. After mating, female dragonfly lay eggs in proper places like fresh water source or suitable plants.

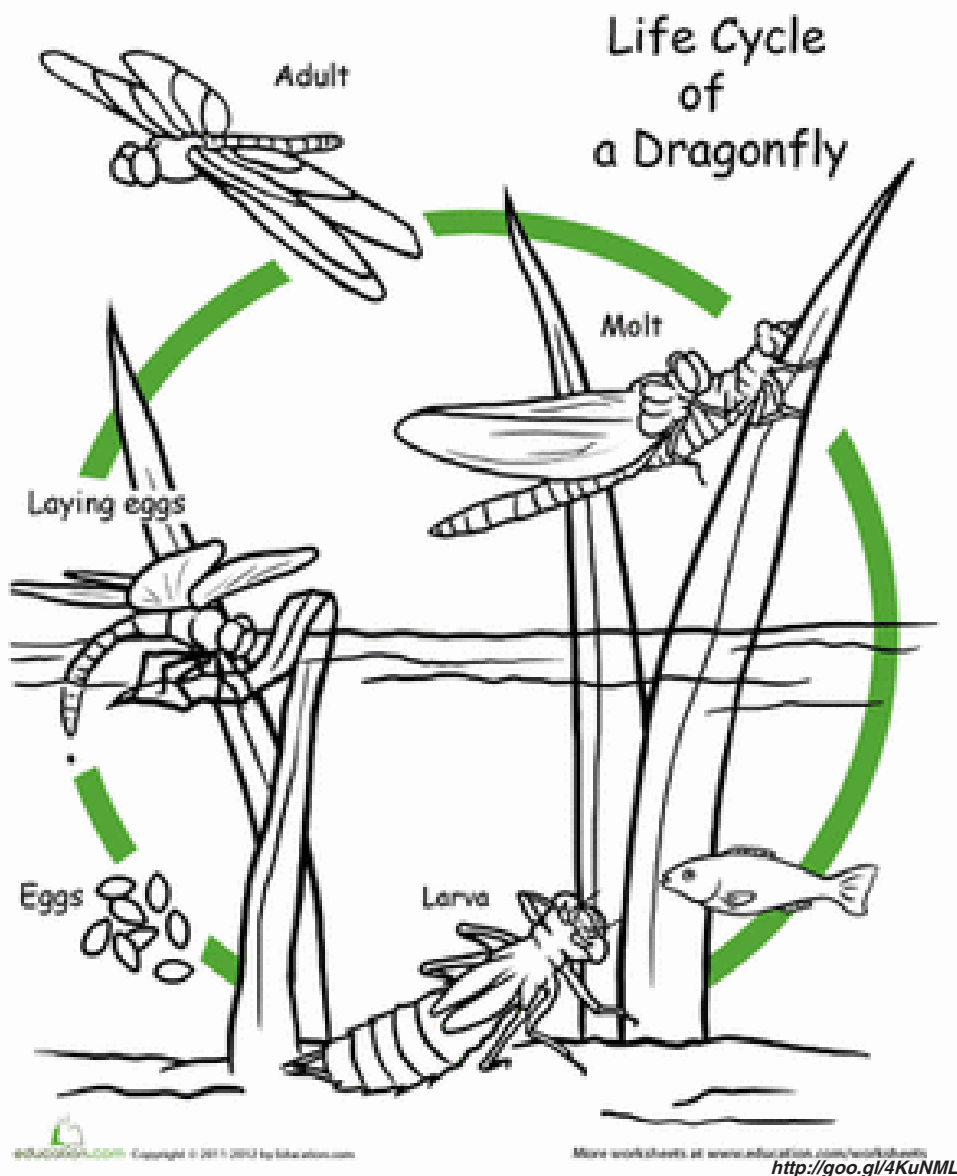
The nymph:

Dragonfly spends most of their life span as a nymph, if the nymph cycle is completed in the beginning of the wintertime, it will remain in the water until spring when it is warm enough to come out. A nymph looks like a little alien creature.

Adult dragonfly

Once the nymph is fully grown, and the climate is right, it will complete the transformation into a dragonfly by crawling out of the water up the stem of a plant. The nymph will remove its skin onto the stem of the plant and will then be a young dragonfly.

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Dragonfly Laying Eggs in the Water



Dragonfly Nymph



Adult Dragonfly

Dragonfly habitat

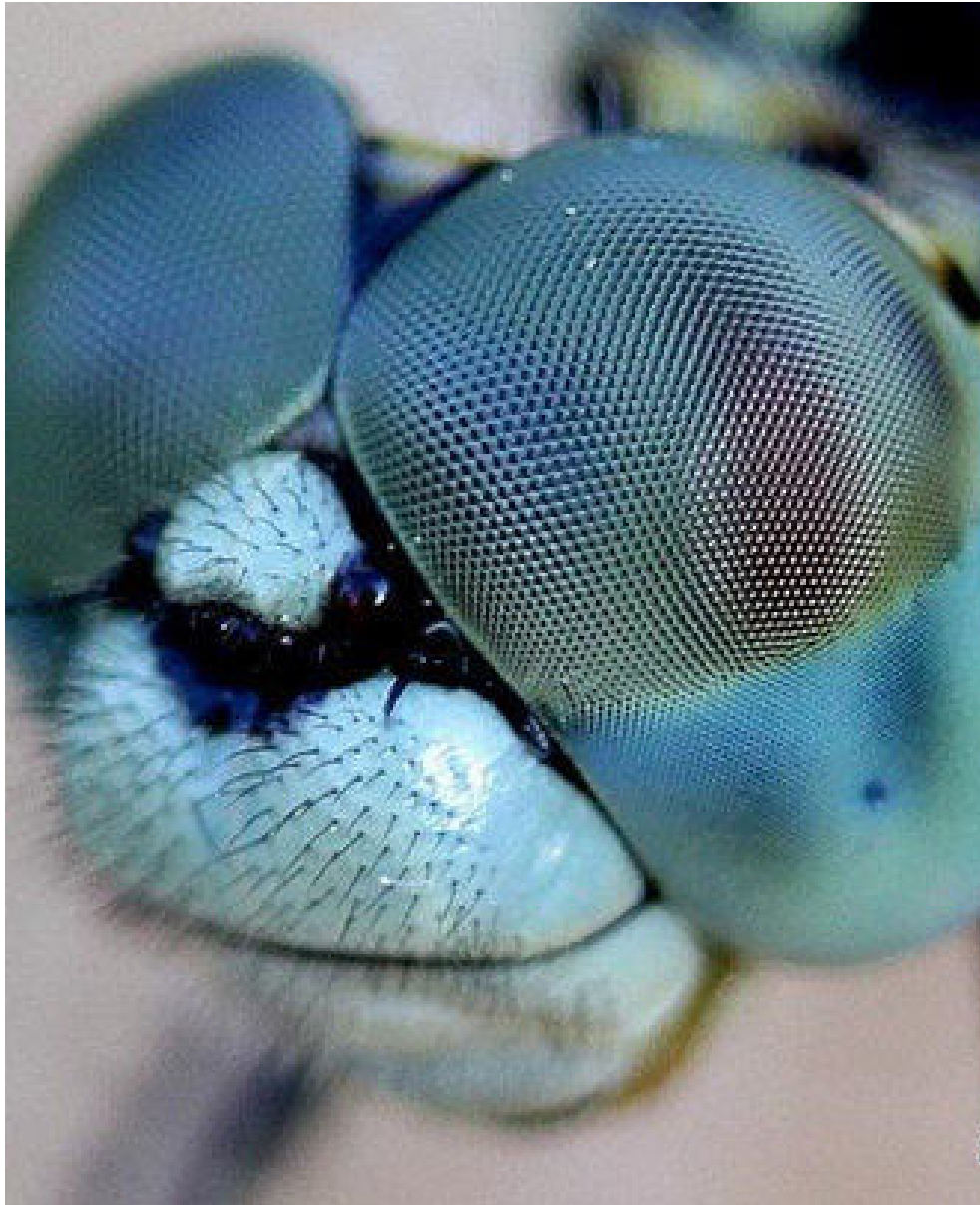
Most dragonflies prefer to perch themselves close to water like rivers, ponds, streams and lake

Adult dragonflies often stay near water, but sometimes travel away from water while hunting or on migration. They are fast fliers, so they tend to hunt in open areas, not in thick trees or other vegetation.

Dragonflies hatch from eggs in freshwater, and spent at least a few months (sometimes several years) as aquatic predators. As they grow they molt (shed their whole skin at once) many times. Once they are big enough, they crawl out of the water and the adult stage emerges from the skin of the nymph. Once they have transformed into the winged adult stage, they stop growing.

Most dragonfly species spend the winter as nymphs in the water, and spend the winter as adults. In few species that lay their eggs in the late summer or fall, the eggs don't hatch until spring. Dragonflies emerge from the water in the warm months of spring or summer

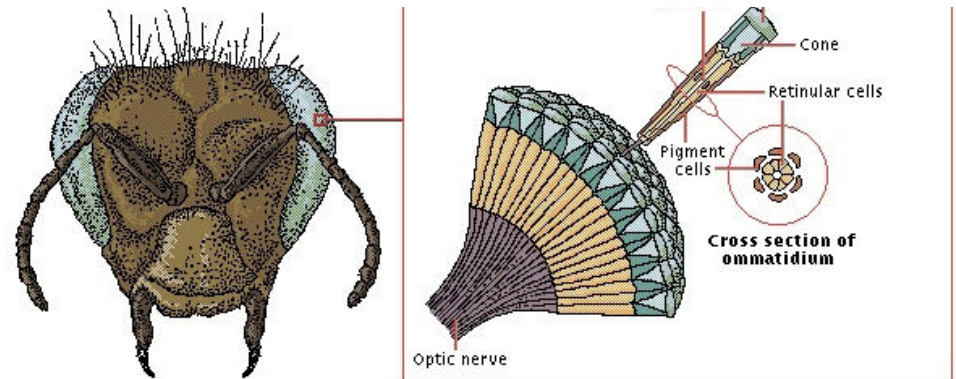
Dragonfly body parts



Compound eye

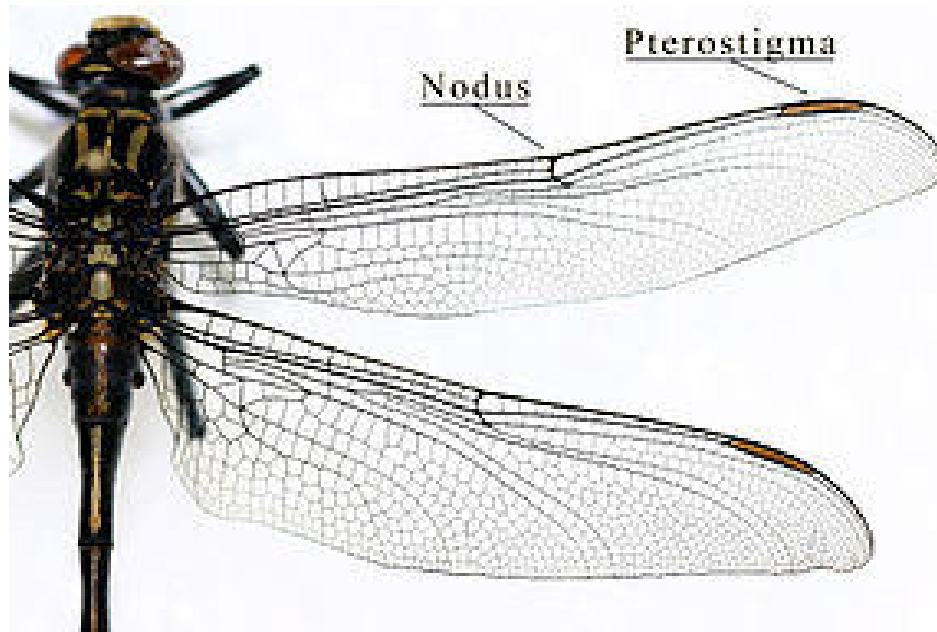
Arthropod eyes are called compound eyes because they are made up of repeating units, the ommatidia, each of which functions as a separate visual receptor

The compound eye is excellent at detecting motion. As an object moves across the visual field, ommatidia are progressively turned on and off. Because of the resulting “flicker effect”, insects respond far better to moving objects than stationary ones. Honeybees, for example, will visit wind-blown flowers more readily than still ones.

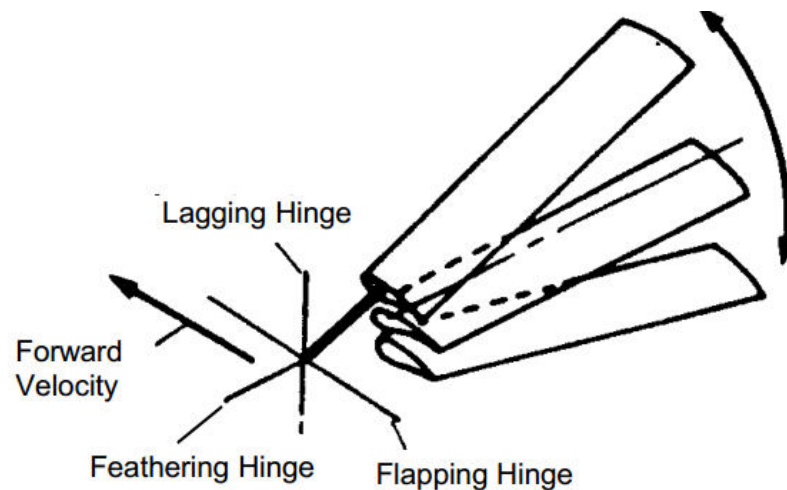


Dragonflies have one of the most elaborate eyes of any insect, capable of pinpointing the motion of a small prey insect several meters away, even while the dragonfly is traveling fast. They have extremely large eyes, which can see in every direction except for the blind spot created by their bodies

Wing



Wing Motion



- Running through each wing is a network of veins that adds strength and flexibility. This allows the dragonfly to curve and cut through the air
- Vein structure is held together by a very thin, shiny film made from chitin
- Unlike an aircraft wing, it is neither streamlined nor smooth.
- Folds facilitate deformation during flight
- Veins increase the mechanical rigidity of the wing

The purpose of the pterostigma and Nodes

Pterostigma, being a heavier section of the wing in comparison to nearby sections, is to assist in gliding

The nodus near the center of the leading edge allows the wing to flex and twist

Wing Motion

Can consider as motion as being composed of three different rotations: flapping, lagging, and feathering. Three Hinges of the Wing Apparatus

Horizontal (flapping)

Vertical (lagging)

Torsional (feathering)

Each hinge occurs at the intersection of a vein and a fold

Direct mechanism.

Downward movement of the wing is the result of the contraction of muscles attached directly to the wing. This flight mechanism is under control of synchronous flight muscle

Dragonfly Flight

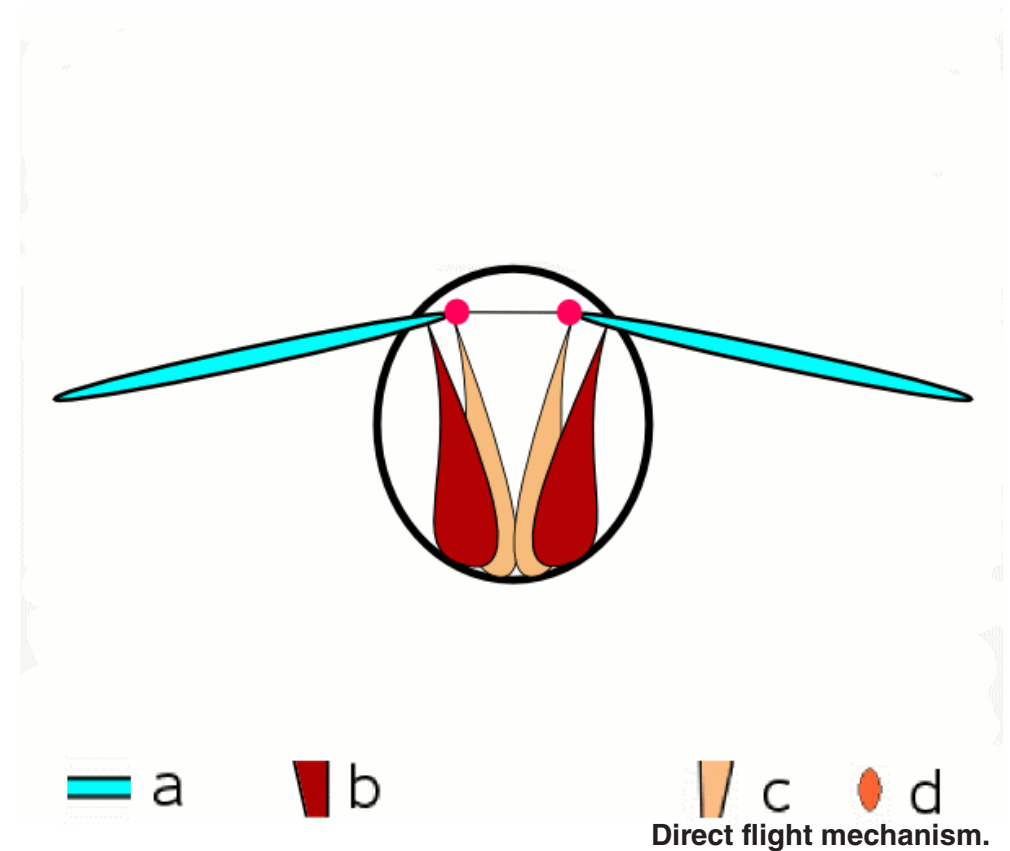
Counter-stroking :-where fore- and hind-wings move up and down about 180 degrees out of phase

Phased-stroking :-where the hind-wings cycle about 90 degrees - a quarter cycle - before the fore-wings

synchronised-stroking :- where fore- and hind-wings move in unison and gliding.

They can fly fast, up to 60 km (37 mi) per hour

Their wings have a rhythm of 20-30 beats per second



Antennae

Dragonfly's antennae are small and their main function is to measure air speed in flight

The Legs

- Dragonfly has three pairs of legs
- Dragonfly are of considerably strength, and are strongly armed.
- Their position close behind the mouth renders them unfit for walking, though they serve very well for climbing
- During flight, all three pairs of legs are carried folded close up under the thorax
- The first two pairs at least are able to hold the prey during flight, while the mouth-parts examine and chew it up
- Each leg consists of five segments or joints

The Abdomen

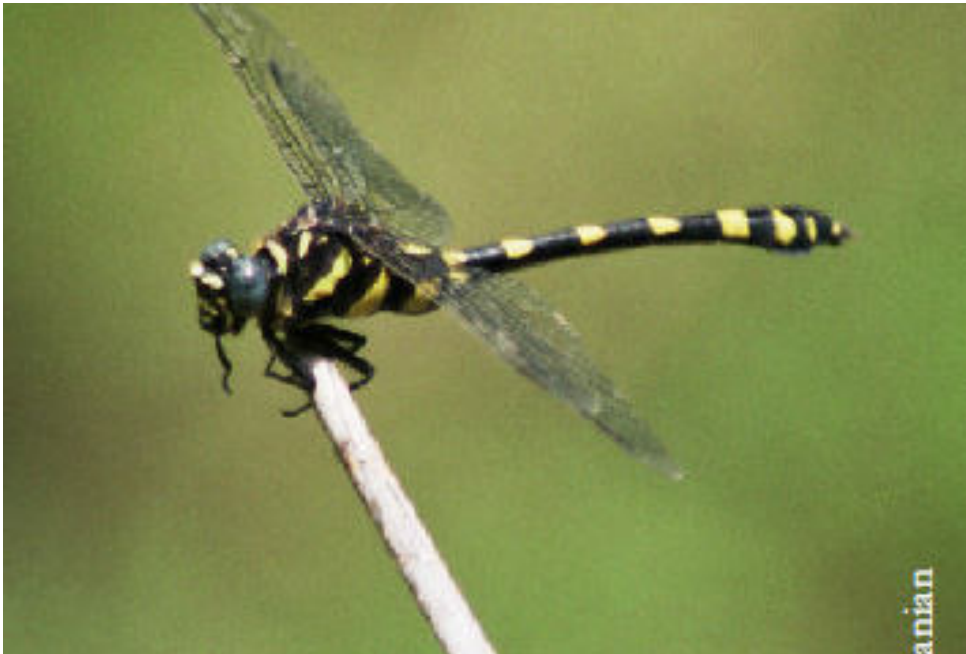
- The abdomen of the Dragonfly consists of ten complete and very distinct segments
- At its extreme end, the abdomen carries a set of anal appendages
- In shape, it is always narrow, and much elongated in comparison with its breadth



The Abdomen

Types of dragonfly(indian)

1. Club Tails



Club Tails are large or medium sized dragonflies. They are generally black or yellow and marked with yellow or green. The eyes are well separated and large. The wings are transparent.

2. Syrandiri Clubtail



A medium sized black and yellow dragonfly with out a clubtail. Eyes: Emerald green above black, with yellow interrupted collar anteriorly and two oblique yellow spots below the collar. It is known only from Silent Valley National Park, Kerala.

3. Common Club tail



Black marked with yellow. Collar complete with oblique dorsal spots. Dorsal side of the thorax has a large yellow central spot. The lateral stripes are yellowish green.

Flight season: Throughout the year.

4. Darners



Darners are large or medium sized, non-iridescent coloured dragonflies. Eyes meet broadly overhead. The wings are transparent and species like the Blue-tailed. Green Darner have amber coloured Hind wing patches. The abdomen is longer than the wings

5. Skimmers

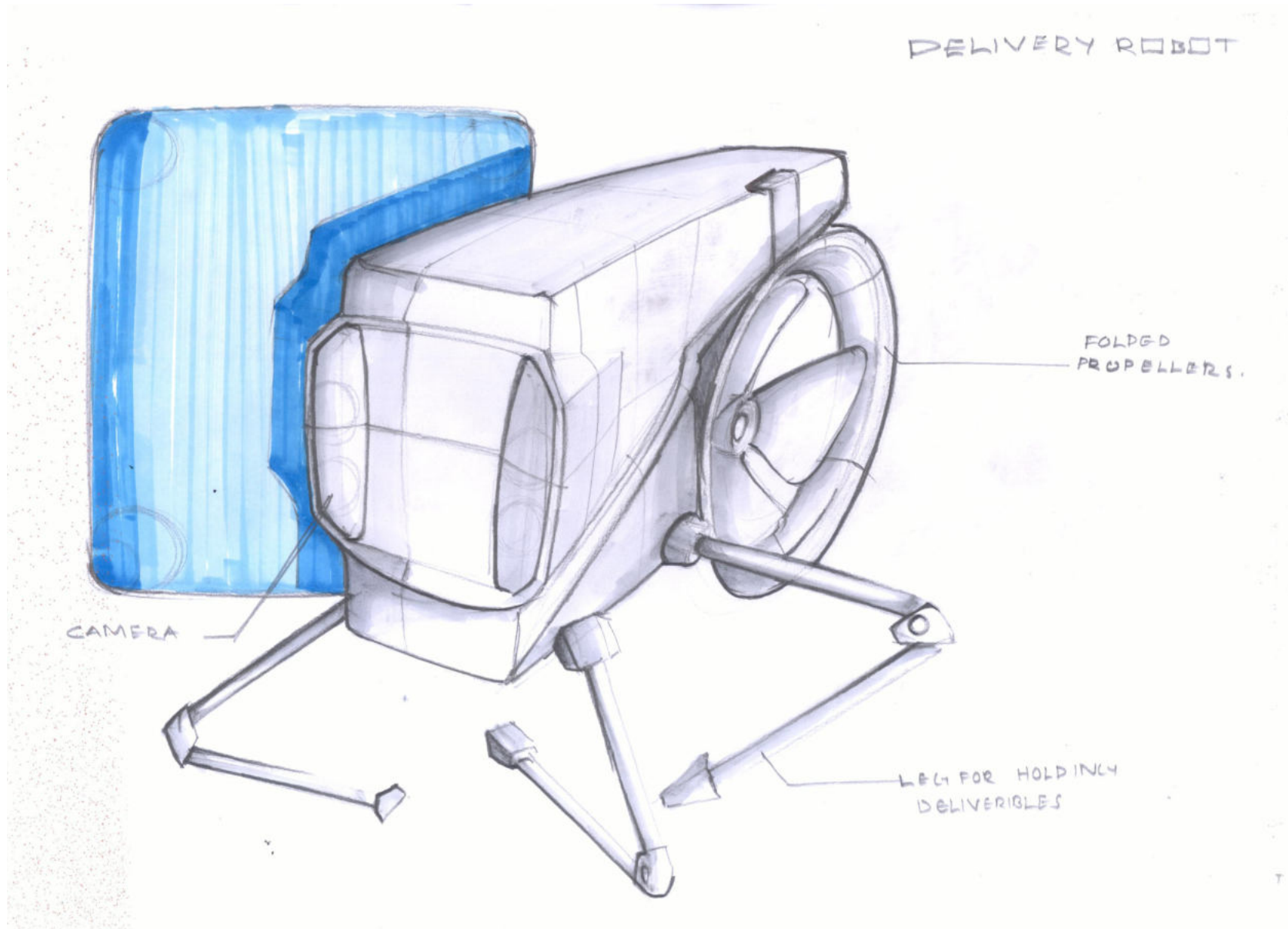


Skimmers are the most diverse group of odonates. They are large, medium or small dragonflies and non-iridescently coloured. Eyes are always broadly confluent. The wings vary in size, shape, width and colouration.

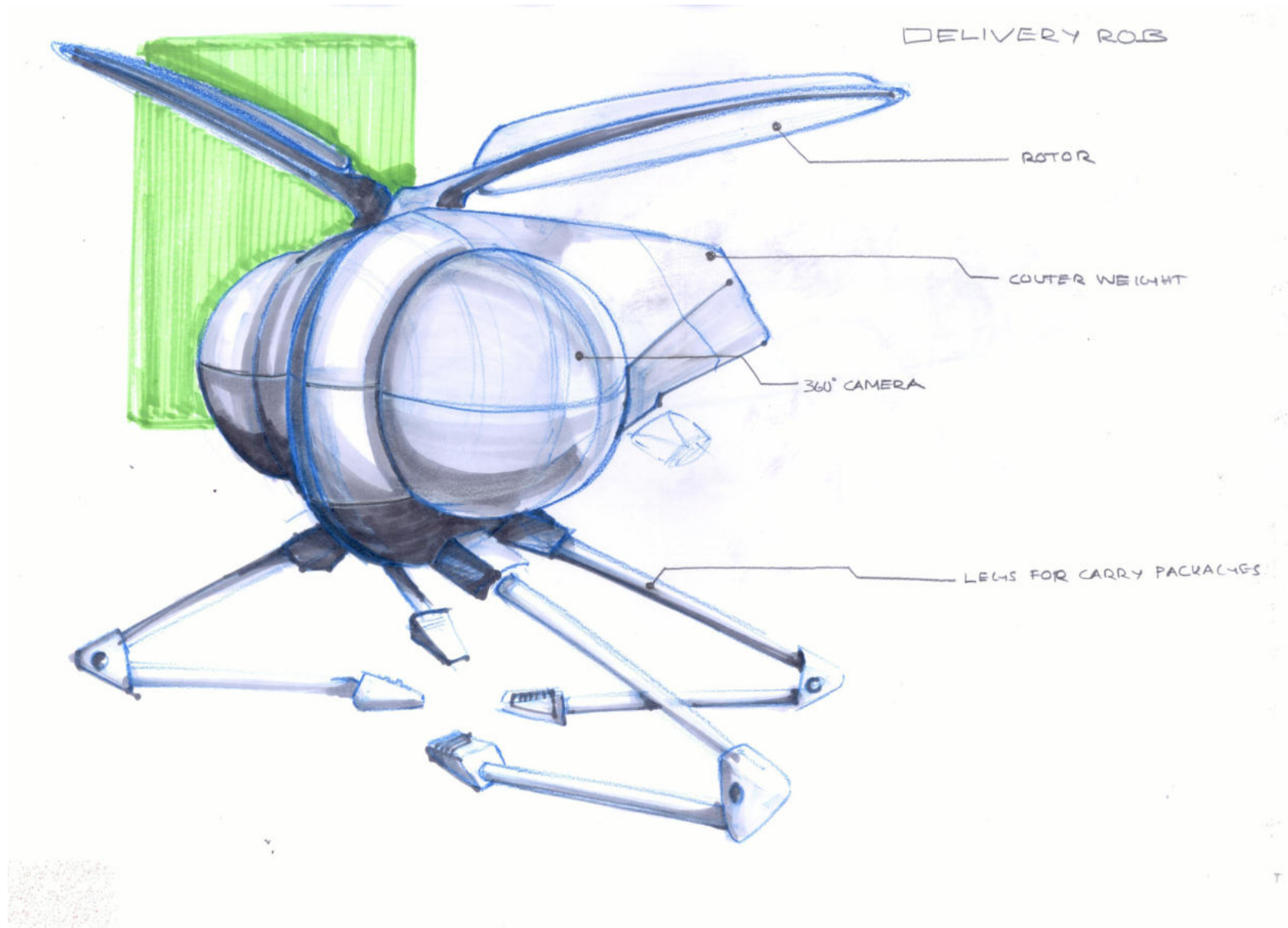
Five interesting features of dragonfly

1. These insects are powerful, capable of lifting more than twice their own body weight
2. Dragonflies also a efficient fliers. Majority of species can travel thousands of miles their seasonal movements
3. A dragonfly is a very strong and good flyer, and can fly at speeds of up to 36 miles per hour.
4. The dragonfly nymph will pull water into its anus, where gas exchange occurs. When the dragonfly expels the water from its rear, it propels the nymph forward, providing the added benefit of locomotion. occurs. When the dragonfly expels the water from its rear, it propels the nymph forward, providing the added benefit of locomotion.
5. Dragonflies have excellent vision. Relative to other insects, dragonfly vision is extraordinarily good. The head consists almost entirely of two huge compound eyes, which gives the dragonfly nearly 360° vision. Each compound eye contains as many as 30,000 lenses, or ommatidia. A dragonfly uses about 80% of its brain to process all this visual information. They can see a wider spectrum of colours than humans. This remarkable vision helps them detect the movement of other insects and avoid collisions in flight

Ideation phase-1

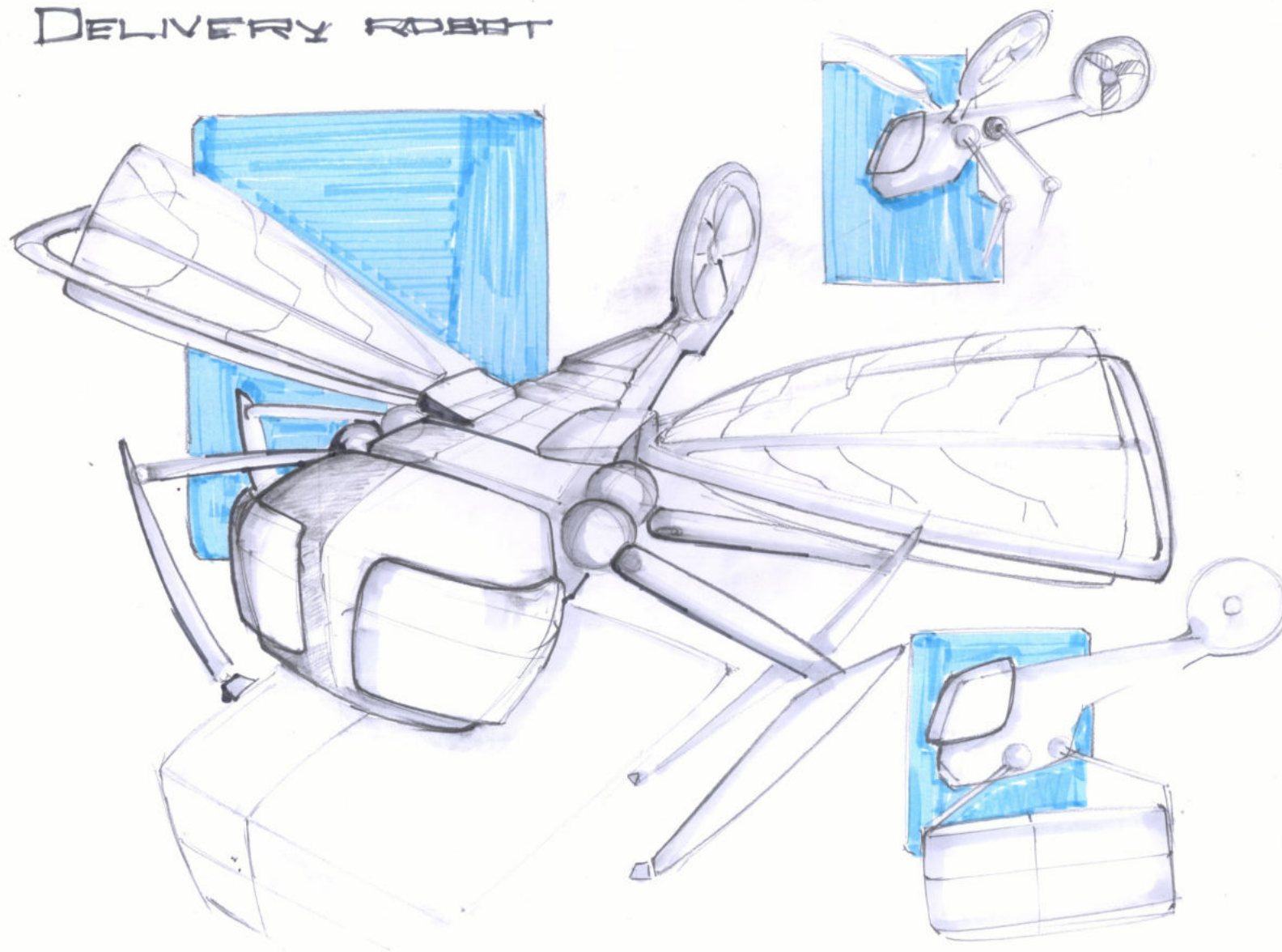


**Delivery ROV
form exploration-1**



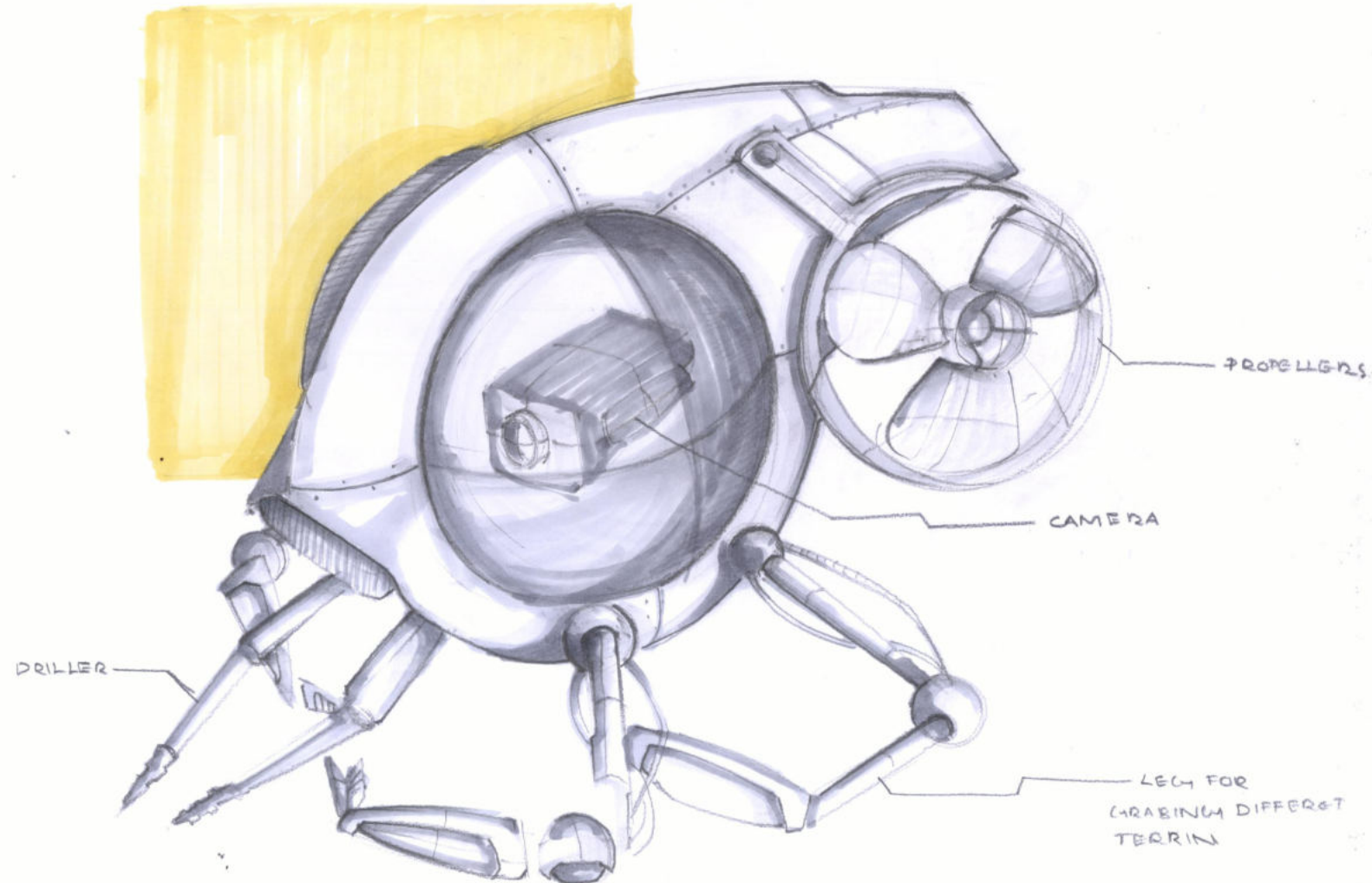
**Delivery ROV
form exploration-2**

DELIVERY ROBOT



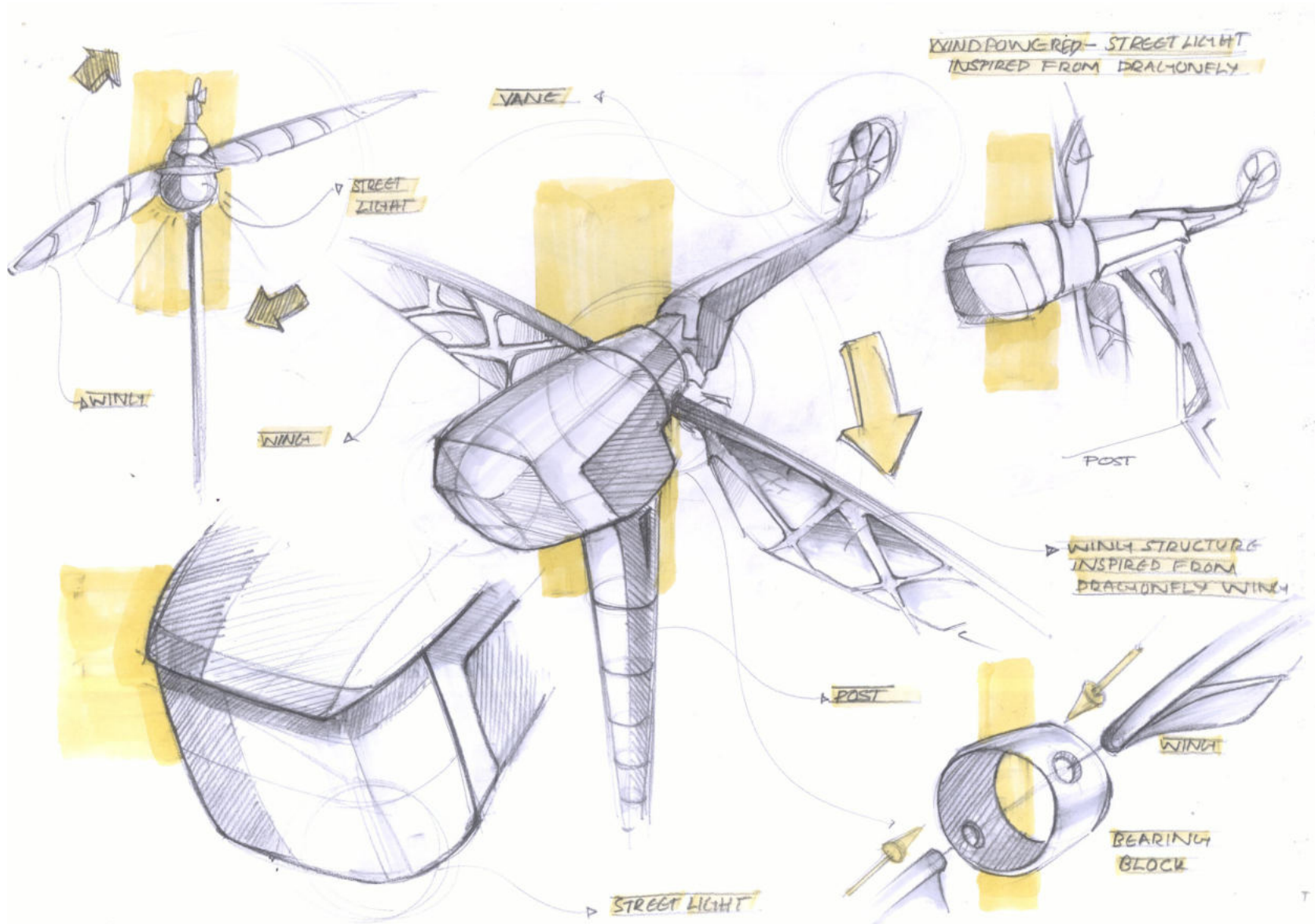
**Delivery ROV
form exploration-3**

ROV FOR GEOLOGICAL SURVEY

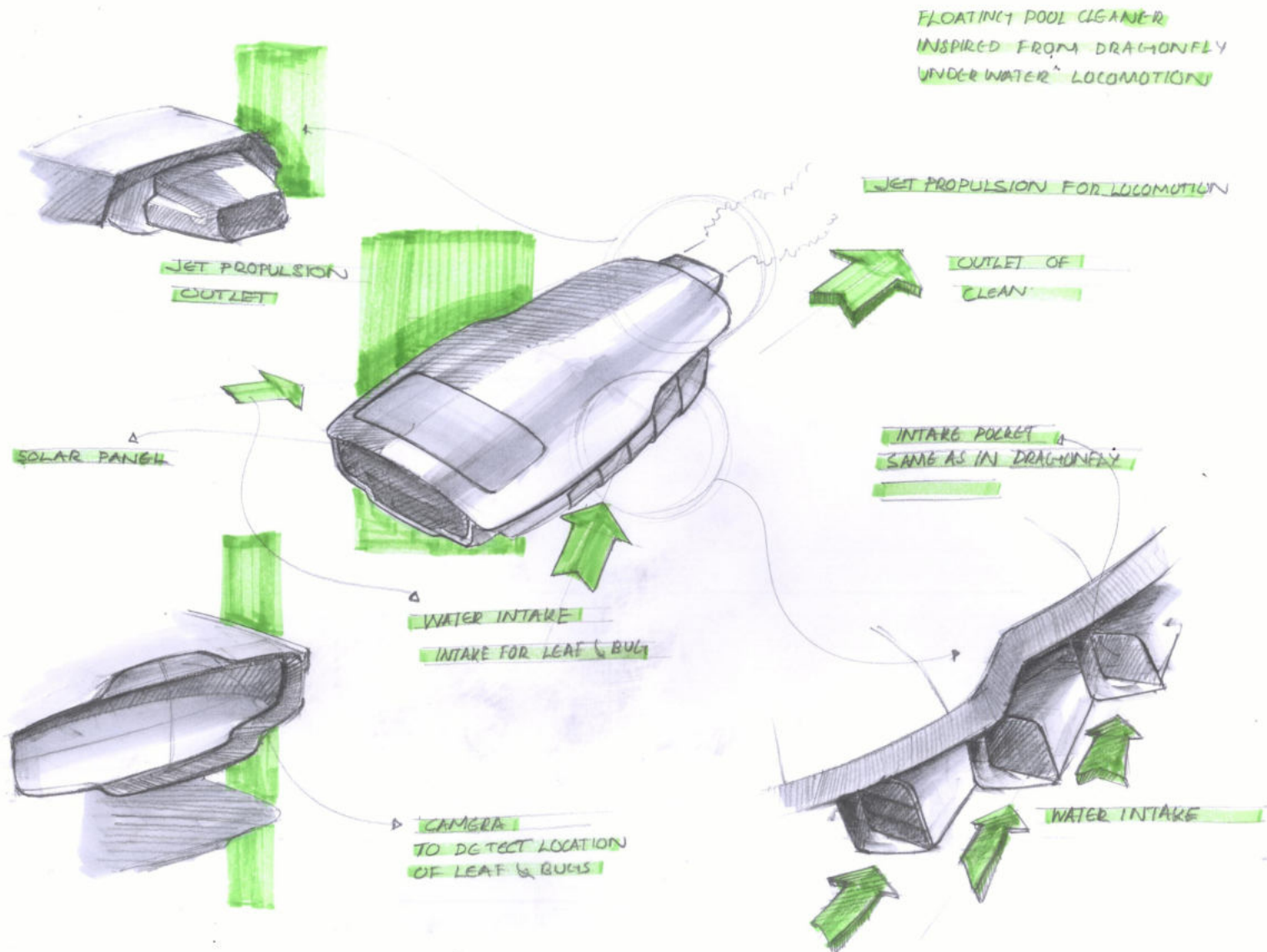


**ROV for Geologi-
cal survey :-form
exploration**

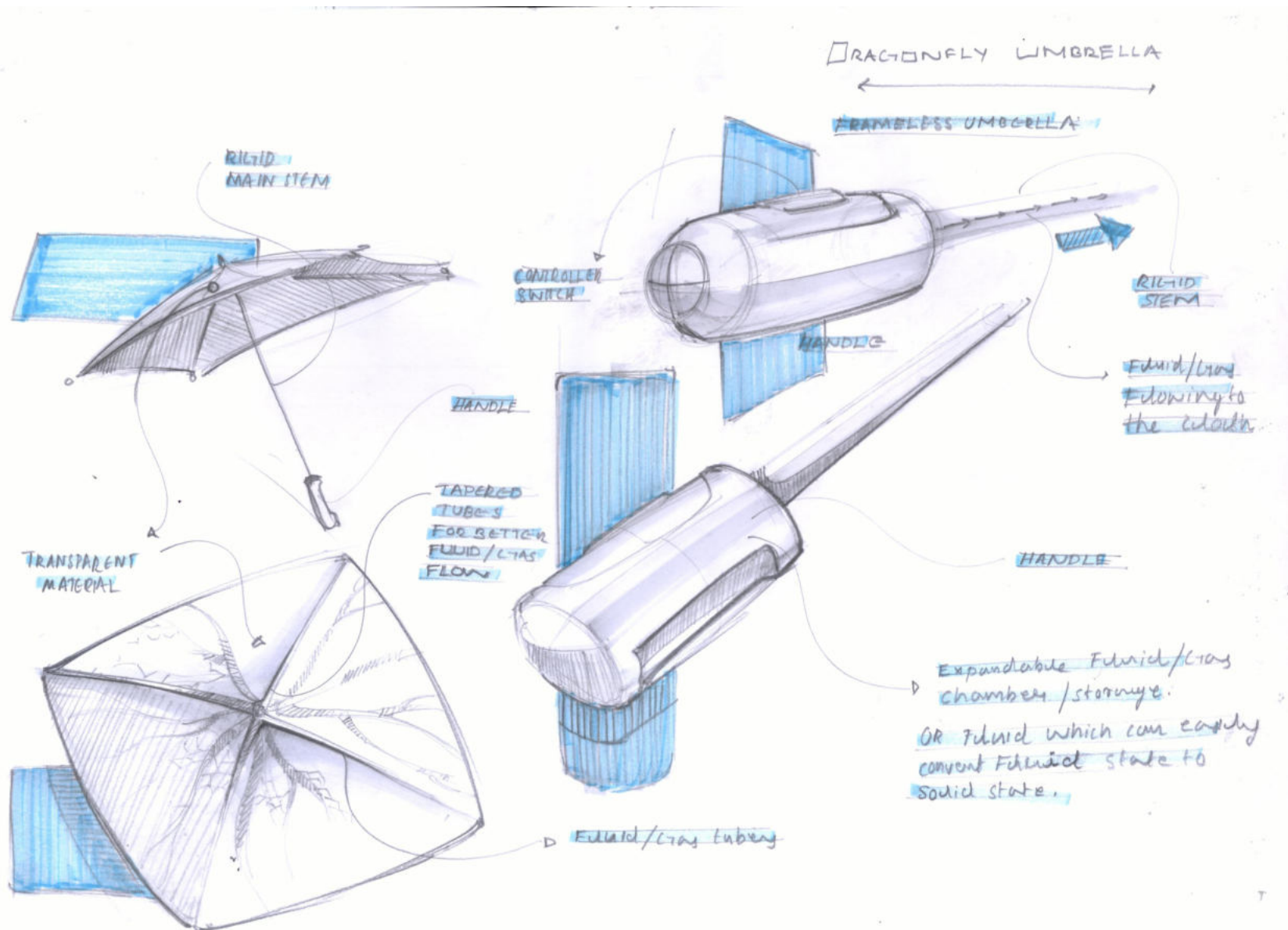
Ideation phase-2



**Wind power
street light:-
exploration**

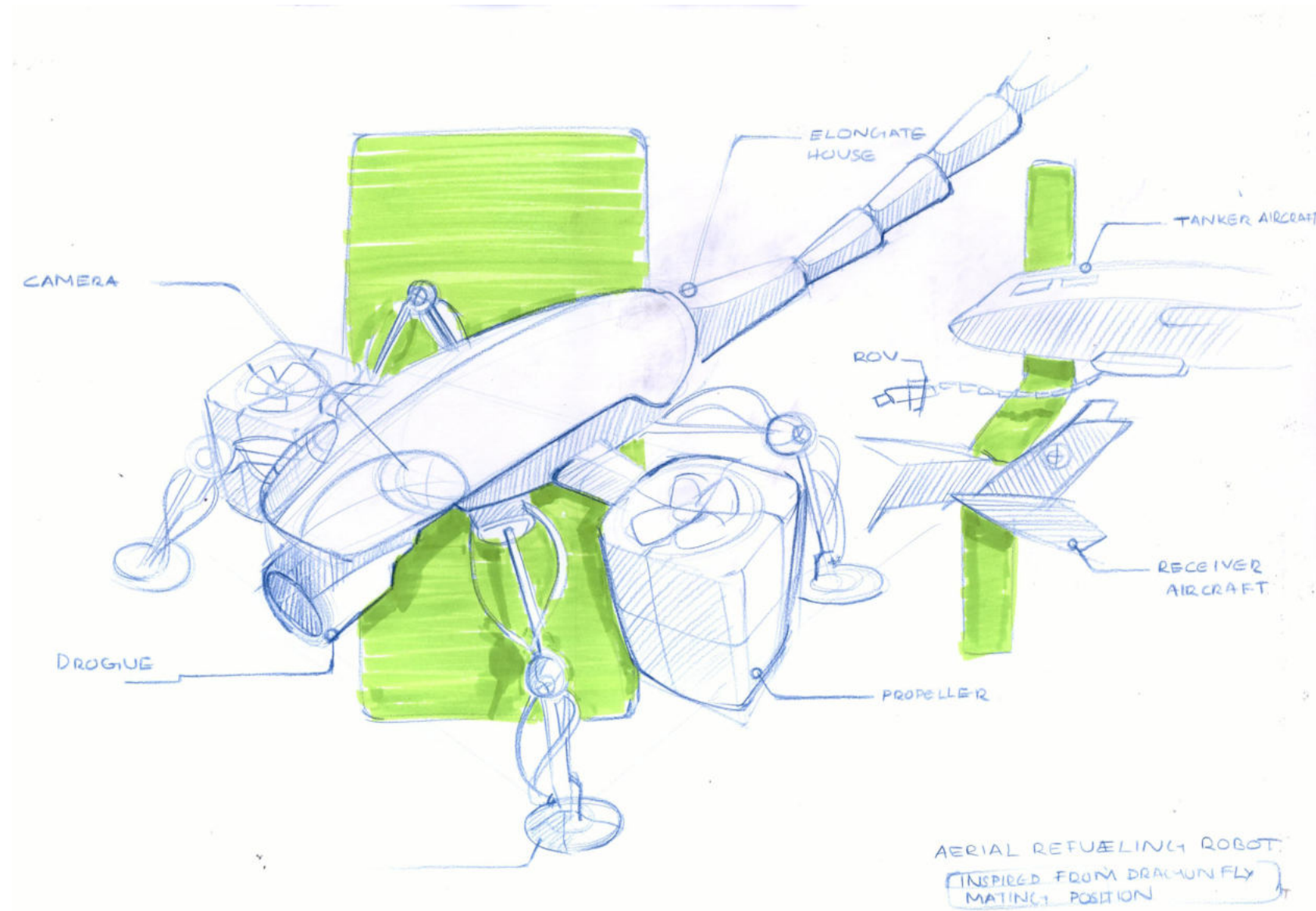


**Floating pool
cleaner:-
exploration**



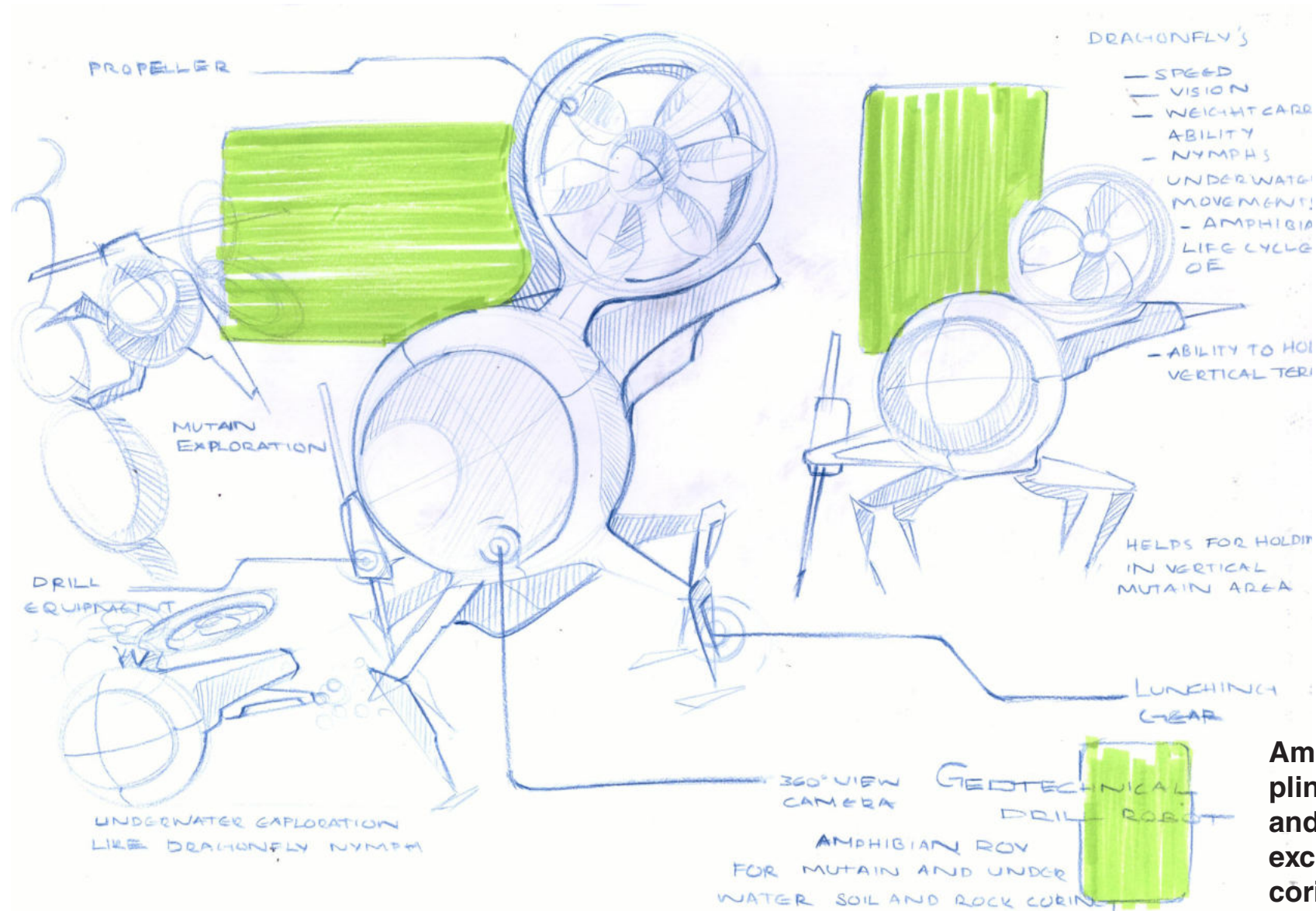
**Dragonfly
umbrella:-
exploration**

Concept-1



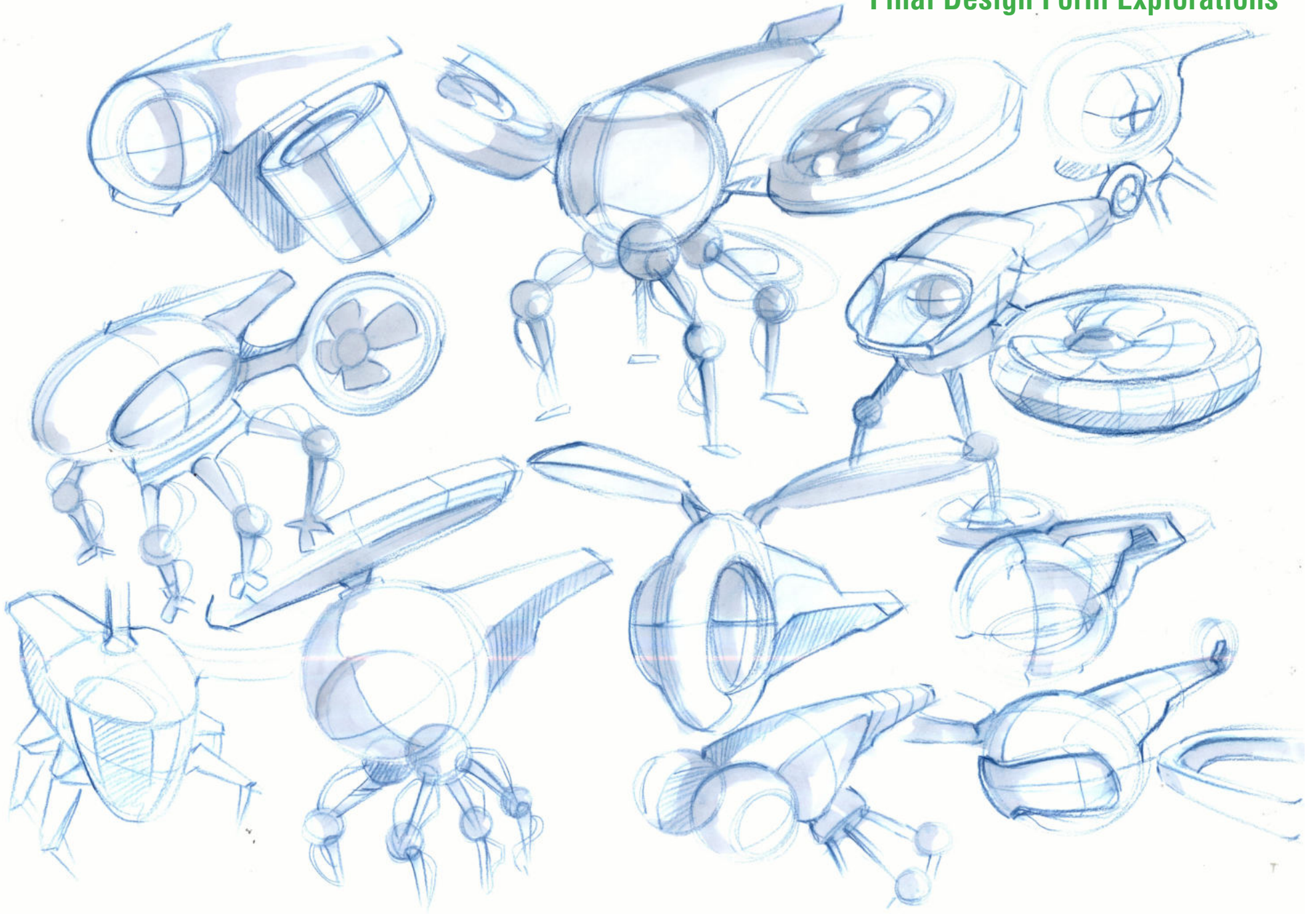
Aerial Refueling Robot:-

Concept-2

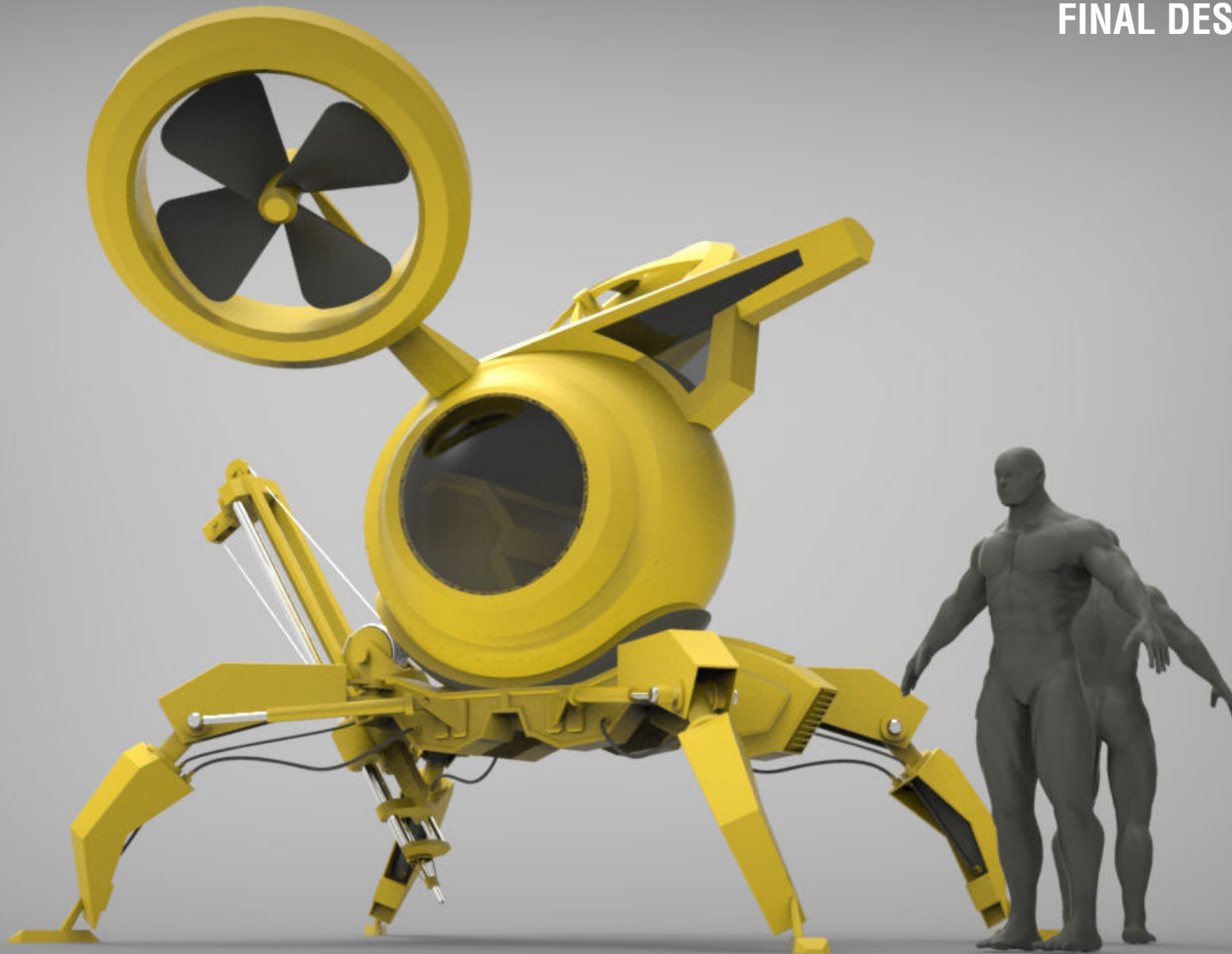


**Amphibion sam-
pling roV for mutain
and under water soil
excavation and rock
coring**

Final Design Form Explorations



FINAL DESIGN



FINAL DESIGN



FINAL DESIGN DETAILS

