Biometry, H23, Test 1

Name: _____ Student number_____

Nouvelle-Calédonie (New Caledonia) is a French territory comprising dozens of islands in the South Pacific. It's known for its palm-lined beaches and marine-life-rich lagoon. A massive barrier reef surrounds the main island, Grande Terre, a major scuba-diving destination. Nouvelle-Calédonie has many unique taxa, especially birds and plants. It has the richest biodiversity in the world per square kilometre.

1. (2 marks) The world's largest extant species of fern, *Cyathea intermedia*, is endemic to New Caledonia. It can grow to over 35m tall. You estimated the heights of eight *Cyathea intermedia* plants:

   26 22 34 16 20 12 34 28

   Compute the mean, the standard deviation and the coefficient of variation of heights of these fern plants.

2. (2.5 marks) *Amborella* is a monotypic genus of understory shrubs or small trees endemic to Grande Terre. The genus is the only member of the family *Amborellaceae* and the order *Amborellales* and contains a single species, *Amborella trichopoda*. *Amborella* is of great interest to plant systematists because molecular phylogenetic analyses consistently place it as the sister group to all other flowering plants. The flowers of *Amborella* bear 10 to 21 spirally arranged stamens, which become progressively smaller toward the center. A sample of 24 flowers had the following number of stamens per flower:

14	16	15	14	19	13	17	15
15	21	9	18	19	12	10	13
14	12	10	20	9	7	16	11

Organize the data into a frequency table with five classes. Draw a histogram based on this frequency table.

3. (2.5 marks) The kagu or cagou (*Rhynochetos jubatus*) is a crested, long-legged, and bluish-grey bird endemic to the dense mountain forests of New Caledonia. It is the only surviving member of the genus *Rhynochetos* and the family *Rhynochetidae*. The kagu is listed as endangered and enjoys full protection in New Caledonia. In the last 6 years the Kagu population in a protected conservation area on Grande Terre has experienced growth of 2.8%, 6.0%, -1.6%, -30%, 2.5% and 4.8% respectively. If initially there were 50 Kagu in the this area, how many Kagu were there after one year, after two years, after three years, after four years, after five years and after 6 years (round to integers)? What is the average yearly growth rate over the six years?

4. (2 marks) Hatchetfish from the family *Sternoptychidae* usually live at depths between 200 and 2,000 metres. Based on decades of experience the New Caledonia fisherman William Larue estmates that the probability he will catch such a fish close to the surface during a day of fishing to be 0.005.

   Surprisingly Mr. Larue has caught deep-sea hatchetfish three times in last 50 days of fishing near the surface of New Caledonia's Toombo Reef. Is this a statistically significant event?

   If Mr. Larue doesn't catch deep-sea hatchetfish again in a year (270 fishing days) would this event be statistically significant?

5. (3 marks) The New Caledonian crow (*Corvus moneduloides*) is a medium-sized member of the family Corvidae, native to New Caledonia. The New Caledonian crows are capable of tool use; some researchers rate these crows second only to humans in tool use. This species is also capable of solving a number of sophisticated cognitive tests which suggest that it is particularly intelligent. As a result of these findings, the New Caledonian crow has become a model species for scientists trying to understand the impact of tool use and manufacture on the evolution of intelligence.

   In a study some very young New Caledonian crows were separated from the flock so that they cannot learn tool use by observing older crows. Then the skills of these separated crows and crows rased in the flock were evaluted on their proficiency of tool use in three levels: basic (B), proficient (P) and genius (G). The results are summarized in the following table:

Skill level	Flock (F)	Separated (S)
Basic (B)	71	62
Proficient (P)	32	60
Genius (G)	22	3

   Consider selecting a random New Caledonian crow from this study. Compute the following probabilities.

   a) $p(P)$, b) $p(F \cap G)$, c) $p(B \cup S)$, d) $p(P|F)$, f) $p(F|G)$ g) $p(F|G^c)$.

   By comparing unconditional with conditional probabilities answer the question: "Is observing older crows important for the development of tool-use in younger crows"? Make sure you provide numerical justification for your claim.

6. (2.5 marks) Recent research has shown that naturally occurring heavy metals in the soil may affect Kagu through their food supply. Kagu in areas where soil levels of heavy metals were low laid more eggs and had higher numbers of fledglings, as well as having smaller home-ranges and higher body mass, than Kagu in areas where the soil was heavy-metal rich. It is though that 32% of all Kagu are in habitats wehere the soil is heavy-metal rich. In these heavy-metal rich habitats 89% of the Kagu have smaller than normal body mass. In the habitats where the soil is not heavy-metal rich 17% of the Kagu still have smaller than normal body mass.

   i) If a Kagu bird has smaller than normal body mass what is the probability it lives in a heavy-metal rich habitat?

   ii) If a Kagu bird has a normal body mass what is the probability it lives in a heavy-metal rich habitat?

7. (2.5 marks) The Kagu is (obviously) the national bird of New Caledonia. Kagu are territorial, maintaining year-round territories of around 10–20 hectares. They have a clan-based social organization, with families composed of one breeding female and one to three breeding males. A study found the following number of families in 100 hectare plots on Grande Terre:

   5 10 9 8 6 8 11

   Compute the coefficient of dispersion. Are the families regularly spaced, randomly spaced or clumped?

8. (3 marks) *Rhacodactylus leachianus*, commonly known as the Leachianus Gecko, or simply Leachie, is a large species of gecko in the family *Diplodactylidae*. The species is endemic to New Caledonia. A survey found the following number of gekos in $1km^2$ areas the "Réserve naturelle intégrale de la Montagne des Sources" reserve.

count	0	1	2	3	4
frequency	4	15	27	12	2

a) Compute the sample mean, the sample variance and the coefficient of dispersion. Does the binomial distribution look like a good fit for this data?

b) Implement a χ^2-test for the goodness of fit of a binomial model with $n = 4$. Does the model fit?